1952

Test of transverse loading platform of 5,000,000 LB. CAPACITY TESTING MACHINE, 1952

Fritz Lab

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Date 16 October 1952

To: H. A. Neville
Lehigh University
Bethlehem, Pennsylvania

Mr. Beedle
This report may be of interest to you,
Ham

LETTER OF TRANSMITTAL

There is forwarded herewith, from the Office of Naval Research, New York, the UNCLASSIFIED MATERIAL, as identified below.

DESCRIPTION

Naval Air Material Center, Philadelphia, Pa., Report No. ASL NAM DE-223 Part II, "AERONAUTICAL STRUCTURES LABORATORY REPORT ON TEST OF TRANSVERSE LOADING PLATFORM OF 5,000,000 LB. CAPACITY TESTING MACHINE".
One (1) copy, UNCLASSIFIED.

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NAVAL AIR MATERIAL CENTER

NAVAL AIR EXPERIMENTAL STATION

Philadelphia, Pa.

3 Jun 52

From: Director, Naval Air Experimental Station
To: Chief, Bureau of Aeronautics (DE-222)

Subj: Report No. ASL NAM DE-223, Part II, Test of Transverse Loading Platform of 5,000,000 Lb. Capacity Testing Machine, forwarding of

Ref: (a) BUAER ltr Aer-DE-222 NA(3) 54680 of 27 Jul 1948

Encl: (1) Nine (9) copies of Report No. ASL NAM DE-223, Part II

1. The subject project was authorized by reference (a). Enclosure (1) is submitted for the information and approval of Bureau of Aeronautics.

2. The report contains measurements of deflections, attachment bolt loads, and stresses and strains of the platform under loads up to a maximum of 1,200,000 lb. total load.

3. This is a partial report of the work conducted on this project. Preparation of systematized maintenance data for both the 5,000,000 lb. capacity machine and the 600,000 lb. machine will be reported as Part III.

H. T. PATTEN, JR.
By direction

EC

REPORT NO. ASL NAM DE-223
PART II

NAVY DEPARTMENT
BUREAU OF AERONAUTICS

REPORT ON

TEST OF TRANSVERSE LOADING PLATFORM OF 5,000,000 LB. CAPACITY TESTING MACHINE

BY

AERONAUTICAL STRUCTURES LABORATORY
NAVAL AIR EXPERIMENTAL STATION
NAVAL AIR MATERIAL CENTER PHILADELPHIA

Authorization . . . . BUAER ltr Aer-DE-222
NA(3) 54680 of 27 Jul 1948

Dates of Test . . . . From 29 Jun 1950 To 18 Dec 1950

Reported by	E. Alter Aero Engr	Test Engineer
Reported by	A. A. Little Aero Engr	Test Engineer
Reviewed by	A. A. Little Aero Engr	Section Supervisor
Approved by	B. M. Thigpen Aero Engr	Division Head
Approved by	J. S. Kean Aero Engr	Head Engineer
Approved by	H. T. Patten, Jr. Commander, USNR	Superintendent, Aero Struc Lab.

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DATE ISSUED 5/19/52

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REFERENCES

(a) Manual of The American Institute of Steel Construction; American Institute of Steel Construction, New York, N.Y. 1948
(b) Report No. ASL NAM DE-223, Part I, Test of Transverse Loading Platform of 600,000 Lb. Capacity Testing Machine
(c) Practical Reduction Formulas for Use on Bonded Wire Strain Gages, Baumberger, R. and Hines, F.; Experimental Stress Analysis, Volume II, No. 1, 1944

PLATES (Cont) NUMBER

ABSTRACT

A strain and deflection survey of the transverse loading platform of the 5,000,000 lb. capacity testing machine was conducted to determine its safe load capacity, and to provide training of operating personnel.

The platform is a structural steel assembly weighing 279,000 lb. which hangs by twelve bolts from the machine bedplate and acts as an extension thereto so that reaction loads of all bending specimens are balanced within the machine.

The platform was tested by applying loads to the midspan of a box girder which was supported by two end fixtures at the maximum platform span of 50 ft.

The platform was weighed and then was loaded up to its capacity which was found to be 1,200,000 lb., which figure includes machine load and specimen weight.

Adjustments of the hanger bolts were made to provide proper foundation-platform clearances and to equalize the loads in the bolts. The resulting bolt loads were within 8% of their average at maximum machine load. The hanger bolt loads, the loads in eight torsion joint bolts in the platform structure, the deflections of the platform, and the strains and stresses of the platform structure were all recorded and plotted versus machine applied load.

During the work above, six operating personnel were trained by instruction and practice in operation of the machine.

It is concluded that the transverse platform is satisfactory for testing bending specimens up to a total machine load plus specimen weight of 1,200,000 lb. However, it is recommended that to prevent damage to the assembly the strains in the hanger bolts be checked whenever 75% of this capacity is exceeded.

1. AUTHORIZATION

The work reported herein was authorized by Bureau of Aeronautics letter Aer-DE-222 NA(3) 54680 of 27 Jul 1948. The transverse loading platform of the 5,000,000 lb. capacity testing machine was tested 29 Jun 1950 through 18 Dec 1950.

2. OBJECT

The object of the work reported herein, as stated in the authorizing letter, was:

a. To conduct an investigation of the strength and deflection characteristics of, and to determine the safe capacity of the transverse loading platform of the 5,000,000 lb. capacity testing machine.

b. Concurrently to provide training of test personnel in the operation and maintenance of the machine.

3. DESCRIPTION

a. The transverse loading platform of the 5,000,000 lb. capacity testing machine is shown in Plate 1. The platform is a structural steel assembly which hangs by twelve bolts from the bedplate of the machine and thus acts as an extension of the bedplate. In this way the reaction loads of all bending specimens tested in the machine balance the machine applied load within the machine itself. This is accomplished as detailed in Plates 2 and 3. (Plate 1 shows also how, in order to attach to the hanger bolts yet clear the machine parts, the platform box beams are loaded in torsion and thus require torsional restraints at the ends. For this purpose, two special bolts were provided at each end of the box beams where they attach to the main platform span.) Balancing the specimen reactions internally eliminates the objectionable features of reacting on the laboratory floor bending specimens having a span greater than the bedplate width of 12 feet. These objectionable features are the high loads which the floor would have to be designed to withstand and the tendency of the machine to lift itself due to an upward reaction shown in Plate 3.

The platform was designed by the Naval Air Material Center Public Works Department to sustain a maximum machine applied load of 1,500,000 lb. plus a maximum specimen weight of 40,000 lb. simply supported over a maximum working span of fifty feet. The foundation piers on which the machine rests were designed to hold the total dead weight of the machine, platform, and specimen. Each foundation pier is built with two levels: an upper level on which the machine rests and a lower level over which the platform passes at midspan. The design assumptions were made that the dead weight of the platform plus specimen would rest at all times on the lower levels, thus requiring the hanger bolts to carry only the machine applied load from the platform back into the bedplate.

The testing machine manufacturer originally specified that a maximum working load of 1,500,000 lb. could be transferred from the platform through the hanger bolts to the machine bedplate. The two center bolts in each group of six were to take 75,000 lb. each and the other four were to take 150,000 lb. each. After installation of the platform the machine manufacturer revised the specified hanger bolt loads to a total of 1,300,000 lb. equally distributed among the twelve bolts. (He stated that this gave maximum stresses of 3,100 psi shear and 7,200 psi bending in the bedplate.) The design assumptions could not be fulfilled however. With the platform and specimen weights resting originally on the pier lower levels, deflection of the platform members and elongation of the hanger bolts under load would cause a downward motion of the platform against the lower levels, allowing machine applied load to be reacted into the foundation. This would result in severe overloading of the lower levels and the already mentioned tendency of the machine to lift itself from the upper levels. Also, the hanger bolts could not be adjusted to take exactly the specified loads, with the result that some bolts (and thus some portions of the bedplate) would be more severely loaded than others. Therefore new performance limits were set up which the platform could fulfill and which took into account the manufacturer's reduced bolt load specification. In doing this advantage was taken of the facts that the bedplate, foundation, and hanger bolt designs contained ample safety factors, that the bedplate and hanger bolts exceeded their specified material strengths (the latter by a wide margin), and that the calculated stresses in the steel bedplate casting were actually well under the safe allowables specified in reference (a). The new conditions were: first, that the hanger bolts would support the platform above the foundation pier lower levels so that all machine applied load would be carried back into the bedplate (along with the platform and specimen weights); second, that the bolts would be adjusted to take within a reasonable tolerance of equal loads; and third, that machine load would be increased until the maximum bedplate stresses and thus the maximum hanger bolt load reached an arbitrary still safe amount of 10% over the manufacturer's specified value. (Adjusting the platform - foundation pier clearances so that the platform deflection would cause the pier lower levels to carry the platform and specimen weights at maximum machine applied load was considered. This was dismissed as virtually impossible to accomplish.) Design notes and construction blueprints for the platform are on file in the Aeronautical Structures Laboratory.

b. The bending test specimen used for applying loads to the platform was a riveted box girder 52 feet long, 7 feet 8 inches high, and 4 feet wide specially designed and manufactured for this project. The girder together with its end fixtures, is shown in Plates 4, 59, and 60. Design notes and construction blueprints for the girder and its accessories are on file in the Aeronautical Structures Laboratory.

4. METHOD

The box girder was supported at the maximum platform working span of 50 feet by means of end fixtures which were fastened to the platform, and was loaded at the center by the machine. The specimen was both loaded and supported by half round bars in order to give simple (knife edge) reactions. The weight of the girder (approximately 100,000 lb.) and fixtures (approximately 12,000 lb.) used in these tests was considerably above the assumed maximum specimen weight of 40,000 lb. However, the extra weight was small in comparison with the total foundation load. Therefore the entire specimen and fixture weight was allowed to rest on the machine foundation. SR-4 resistance wire strain gages (type A-11) were used to measure the loads in each of the twelve hanger bolts. These gages were installed at 90° intervals around the circumference of each bolt and the installation was made permanent for future use. In addition, to measure the loads in the eight square torsion joint bolts (shown in Plates 1 and 5 also) at the ends of the box beams two type A-11 gages were permanently installed back-to-back on each bolt. The loads were obtained by averaging the strain readings to eliminate bending effects, and multiplying in accordance with: Load = Area x Modulus of Elasticity (E) x Average Strain. The nominal specification value of $E = 29 \times 10^6$ psi was used. The test then proceeded as follows:

a. The weight of the platform was determined: The box girder was first lifted clear of the platform by the machine crosshead. The platform was then picked up free of the nuts on the hanger bolts by means of eight hydraulic jacks. With the bolts unloaded, zero readings on the strain gages were taken. The nuts were turned up far enough to assure that the platform would be clear of and thus not transmit load to the foundation when lowered. The platform was then lowered and the strain gages read. The sum of the loads in the twelve bolts gave the weight of the platform plus the end fixtures attached thereto. The scale-measured weights of the end fixtures were then subtracted to give the platform weight. (Because the magnitude of strain induced in the twelve hanger bolts by the weight of the box girder was very small and the accuracy of measurement thus very low, the weight of the box girder determined in reference (b) was accepted as correct.)

b. The nuts on the hanger bolts were adjusted so that:

(1) The loads in the bolts were approximately equal and no bolt was overstressed (through either overloading or local stresses induced by bending) when the maximum machine load was applied.

(2) (a) The platform was sufficiently clear of the foundation pier lower levels so that when it was deflected downward under the maximum machine applied load, load was not transmitted from the platform to the foundation pier lower levels.

(b) The platform was sufficiently close to the foundation pier lower levels and the decking atop the platform remained fairly level with the laboratory floor.

These aims were accomplished by successive approximations. First, the loads in all twelve hanger bolts were made approximately equal under the dead weight of the platform plus specimen. Then as high a machine load as believed prudent was applied and the strain gages were read at this load. The strains were checked to make sure that none approached yield, and the loads in the bolts were computed. From the bolt loads the necessary adjustments of the nuts were estimated. Then the platform was unloaded and picked up on hydraulic jacks, the nut adjustments were made, the strain gage zeros were re-read, the platform was lowered, and the machine applied loading was repeated. When the loads approached 1,000,000 lb., the clearance between the platform and foundation was checked to determine whether the platform was approaching the foundation fairly evenly.

c. The torsion joint bolts at the ends of the platform box beams were adjusted so that under preload conditions using the moment arms assumed in the design of the platform, the torsion moments produced in the box beams by the hanger bolts equalled those produced by the torsion joint bolts. In making these adjustments, the loads in all eight torsion joint bolts were made approximately equal. The adjustments were made by manually tightening the nut on each bolt in turn to preload the bolt to the proper load as computed from the strain gage readings. Then, because of the interaction of each joint upon the others, successive readjustments were made until as even a distribution as feasible was obtained.

d. A complete deflection and strain survey of the platform was performed after the bolts were fully adjusted. For the survey, gages were installed on the platform as follows:

(1) Dial gages were attached to the platform at pertinent points as shown in Plate 6, and measured deflections with respect to the fixed foundation. No gages were placed North of the platform centerline under the assumption that motion of the platform would be essentially symmetrical.

(2) Strain gages were placed at pertinent points on the platform as shown in Plate 7. The number of gages and the gage locations used were to some extent arbitrary, determined by consideration of expected points of high stress, points where stress determination was of interest, limitation of the gages to a practical number and past experience in placing gages.

(3) Scratch marks for filar micrometer measurements were placed at the North and South corners of the East end of the box beams in position to measure any separation under load between the box beams and the main span beam.

Load was then applied at 100,000 lb. increments up to 1,100,000 lb. machine load. At each increment the dial gages, strain gages and filar micrometers were read and at high loads foundation clearances were checked.

Stresses at the single gages were obtained by use of stress = Modulus of Elasticity (E) x Average Strain. The principal strains and stresses, maximum shear strain and stress, and their orientations at the rosette gages were computed by the method of reference (c).

The nominal specification values of $E = 29 \times 10^6$ psi and $\nu = 0.33$ were used. It is to be noted that except for strain gages on the bolts, all strain gage and dial gage zero readings were taken with the platform resting under its own weight plus that of the specimen and fixtures.

e. During performance of the work outlined above, both technical and mechanical personnel were given instruction and practice in the various phases of operating and maintaining the machine. The following items were included in the training program:

(a) Lecture on physical layout of the machine.
(b) " " operation of the machine.
(c) " " weighing system of the machine.
(d) Practice in installing specimens.
(e) Practice in operating the machine.
(f) Practice in performing maintenance on the machine.
(g) Practice in adjusting and maintaining the weighing system.
(h) Installation of specimens and operation of the machine under supervision for this project and for other test work in the machine.

The emphasis on the items listed varied according to the rating of each person. In addition, a tentative systematized maintenance procedure was prepared which will be presented in Part III of this report.

5. RESULTS

a. The measured weight of the platform is 279,000 lb. The measured weight of the box girder is 100,400 lb. and the measured weight of the end fixtures is 12,000 lb. (6,000 lb. each).

b. The hanger bolts were adjusted so that:

(1) Their loads were brought within eight percent of their indicated average load at the maximum machine applied load. (See (d) below for the final bolt loads.) Because of the size of the components, the number of bolts, and the great sensitivity of bolt loads to small nut adjustments which made adjusting very difficult and time consuming, the results above are considerably better than expected.

(2) The clearance between the platform and the foundation pier lower levels at maximum load was brought to a reasonable minimum rather than the smallest possible value because of the catastrophic effect of each readjustment of the overall platform level on the hanger bolt load distribution. The final clearances between the platform and the piers averaged approximately 5/8" (North side) and 1/2" (South side) with the platform unloaded.

c. The square torsion joint bolts at the ends of the platform box beams were adjusted within eight percent of their indicated average load under preload conditions. This average was 28,050 lb., 10% above the 25,500 lb. indicated from design considerations. The final bolt load data is covered in (d) below.

d. The results of the final survey are as follows:

(1) The average strains and the loads in the hanger bolts are tabulated in Table I. The bolt loads are plotted individually in Plates 8 through 19 and their distributions are presented in Plates 20 and 21. At maximum load the maximum variation of an individual bolt load from the average is 7.3%. Plate 22, however, which compares the total hanger bolt load with the machine applied load, shows that at high machine load a considerable discrepancy exists between the total load on the bolts as measured by the strain gage readings and as obtained from the sum of machine applied load plus platform and specimen weights. (The latter is shown by the dotted line.) Plates 8 through 19 show that the rate of load take-up falls off at high load in the same manner for all hanger bolts. This tends to rule out gage difficulties etc., because all the bolts would not become subject to the same difficulties at the same time in much the same amount. Part of the discrepancy might be explained by total possible experimental inaccuracies, the principal parts of which are errors of testing machine (1/2%) strain gages plus strain indicator (2%), strain gage switching unit (8 micro inches per bolt or 1-1/2% at maximum load), and modulus of elasticity (3%). Part of the discrepancy might also be explained by zero shift in the strain gages. However, Table I shows this to be very small (see zero readings after unloading). The explanation remaining is that the foundation pier lower levels took enough load to cause part of the discrepancy. Although there is no definite proof of this, examination of the platform showed that it probably occurred as follows, without the platform touching the piers: where the platform passes over the piers, foundation bolts pass through holes in the lower flanges of the platform main span beams. The concentricity of these holes with the bolts is not good, and considerable rubbing occurs. At high load the flexing of the beams probably causes pressure of these bolts against the hole edges and transmission of a considerable load. This load, however, was always very much below the pier lower level design capacities and is not expected to cause difficulties during operation of the platform.

(2) The average strains and the loads in the torsion joint bolts are recorded in Table II, are plotted individually versus machine load (both bolts in each joint per graph) in Plates 23 through 26, and have their distribution plotted in Plate 27. The design of these torsion joint bolts to react the torsion in the box beams from the hanger bolts was made by using assumptions carried over from bracket design, neglecting effect of relative stiffnesses of the members, neglecting the tension carrying ability of the rivets in the joints, etc. The torsion joint bolts were preloaded by manually tightening the nuts to near the 25,500 lb. indicated from the design as correct with deadweight load in the hanger bolts. However, because the behavior of the joints did not follow the design assumptions, additional load in the hanger bolts produced much less than the predicted additional load in the torsion joint bolts. Manually preloading the torsion joint bolts more heavily was not feasible and its advisability was by no means certain. Therefore, the torsion joints were merely observed closely throughout the test program. No evidences of incipient or actual failure were observed. Plate 27 shows that as machine load increased the loads taken by the inside torsion joint bolts fell behind those taken by the outside ones, because of bending of the box beams with the main span beams as supports.

(3) The dial gage data are presented in Table III with all deflections referenced to the position of the platform under its own plus specimen and fixture weights. The individual gages plotted versus load and the distributions of the deflections are presented in Plates 28 through 36. It is noted that for many of the deflection plots, curvatures comparable to the plots of the hanger bolt loads are present. This is attributed to the transmission of load through the foundation bolts as previously noted and consequent lessening of the deflection rate.

(a) Plate 28 shows the deflections of the loaded cross-span at the South end of the platform and of the center of the platform. The center moved down approximately 3/8" while the cross span deflected approximately 3/4" at the ends and 7/8" at the center. The 7/8" is the maximum deflection of the platform.

(b) Plate 29 plots the deflections of the bottoms of the six south hanger bolts and Plate 30 presents the distribution of these deflections. It is seen that, although the relative magnitudes of the deflections are (except for gage 2) in the order to be expected from the relative loadings of the bolts from preload, the deflection curves are erratic, the distribution of deflection is poor, and the magnitudes of the deflections are considerably greater than predicted from the bolt strain data. The reasons for these difficulties are not apparent, although one contributary cause is the deflection of the bedplate casting under load and another may be the fact that the motions measured are considerably smaller and the accuracy thus less than with any other dial gages in the test. In any event, the hanger bolt bottom deflections presented in Plates 29 and 30 cannot be considered reliable.

(c) The south box beam deflections plotted in Plates 31 and 33 show the curvature at high loads, and all behave as expected except for gage 13 which showed an unexpected reverse curvature at low loads. Extrapolating this curve as shown by the dotted line in Plate 31 gave results which were more consistent with the data from the other gages. Therefore the extrapolated curve was used in all other graphs using this gage. That this is only approximate is realized. The deflection distributions are plotted on Plates 32 and 34 for the South and North sides, respectively. (In all distributions, the points were connected by straight lines because not enough dials were used to obtain good curves in view of the span involved, the riveted type structure, cover plate removal, etc.) The deflections of the north side gages near the hanger bolts are much larger than the bolt motions expected from bolt elongations and bedplate deflections. However, this is as expected in view of the spanwise and torsional deflections of the box beam plus its overall tilting from horizontal due to flexure of the main span. (For example, gage 11, the closest to the bolts, shows about 0.06" deflection whereas the center bolt elongations are near 0.03" from preload. However, the gage is 4-1/2" south of the beam edge and 6-1/2" south of the bolt center so that a box beam tilt of less than one third of a degree would give this difference.)

(d) Plate 35 shows the twist of the south box beam versus load, as obtained from the difference between the two dial gages at each spanwise station, and Plate 36 shows the distribution of this twist. Plates 31 through 36 show that the maximum box beam deflection is about 0.38 inches and the maximum twist is about 0.14 inches.

(4) The strain gage data are presented in Table IV and are plotted on Plates 37 through 58. The strains and stresses at all gages mounted on the platform are referenced to the platform resting under its own weight plus that of specimen and fixtures. Actual true zeros cannot be obtained because it is not possible to compensate for the effect of platform weight on each gage; also this weight effect does not strain the platform the same as machine applied load so extrapolating back from the measured data is not possible. However, it will be seen that all stresses obtained are quite safe so that true stresses being somewhat higher is not critical. Tensile strain and stress is positive, compression is negative. In the plates tension is plotted to the right of the origin and compression to the left.

(a) The maximum bending stresses in the bottom flanges of transverse beams 1, 2, and 3 are shown in Plate 37 by gages a, b, and c respectively. The loaded span (number 1) shows a safe maximum stress of 9,000 psi tension, and because of twist of the main span beams caused by flexing of the loaded end span (plus possible carry over in the connections between transverse beams), spans 2 and 3 also show some tension in the lower flanges. This amounts to about 3300 psi and 500 psi in beams 2 and 3 respectively. The principal stresses and maximum shear stresses in the webs at the east ends of transverse beams are presented in Plates 38, 39, and 40. Again a decreasing amount of stress is carried over into beams 2 and 3 from loaded beam 1. Also, Plate 38 shows that considerable bending exists in the web of beam 1, inasmuch as the side-to-side difference in minimum principal stresses reaches almost 1,800 psi out of an average of 3,900 psi. However, the difference in maximum principal and shear stresses is less pronounced. Also, the fact that the back-to-back divergences appear at a constant rate rather than a rapidly increasing rate means that buckling was not present. Thus the differences, although considerable, are not critical. The maximum principal stresses encountered are 5250, 2070, and 1160 psi tension for the three spans, and the maximum shear stresses are 5030, 1010, and 640 psi. All these are safe values.

(b) The stresses on the lower flanges of the connecting members between beams 1 and 2 are shown by gages d, e, and f on Plate 41. The magnitudes are in all cases very small. However, the magnitudes of the stresses in the cross braces are considerable as shown by gages g, h, and i on Plate 41. Since these braces are above the neutral axes of the main span beams, flexure of these beams puts gages h and i in tension but g in compression. The symmetricalness shown by gages h and i is very good. The maximum stresses were 5,500 psi tension in gage h and 4,300 psi compression in gage g. Plates 42 and 43 show the stresses in the webs of the members connecting transverse beams 1 and 2 to be very small, 1,500 psi and 1000 psi maximum for rosettes D and E respectively.

(c) Plate 44 shows the lower flange stresses of the main span East beam for gages j and k. At midspan the maximum compression stress recorded is 6,100 psi, although the gage was on the inside of the flange and the actual maximum was thus slightly higher. The stresses at the rosettes on the main span webs are shown on Plates 45, 46, and 47. Rosettes G and G', and H and H', which were located on the neutral axis of the beam show practically pure shear, no bending, and no buckling. Rosettes F and F', which were both below the neutral axis and in the region of influence of the torsion joint reaction bolts, show fairly close to pure shear with principal compressive stress slightly larger than tensile. Some bending caused by the unequal bolt loading was present. All maximum stresses were slightly over 5,000 psi except for rosette F where about 7,000 psi compression, 5,000 psi tension, and 3,000 psi shear were reached.

(d) The stresses in the diaphragms at the ends of the South box beams are shown in Plates 48 and 49. Unfortunately, gage m' at the bottom of the West end diaphragm was inoperative. The tops of the diaphragms were in compression while bottoms were in tension, with stresses all under 5,000 psi. A large amount of bending is shown by the back-to-back gage differences to be present. The stresses in the support angle legs for the torsion joint bolts are presented in Plates 50 and 51. These gages all show high compressive stresses as expected except for gage s. This gage showed no stress because part of the angle on which it was placed did not bear against the plate carrying bolt loads into the angles, and the gage was directly above a non-bearing point. Because the gages all had to be placed somewhat above the bottoms of the angles where they contacted the loading plates, the maximum stresses which occurred at these points were slightly higher than those registered by the gages. However, the indicated stresses do not exceed a safe 8,500 psi.

(e) The stresses in the South box beam as measured by rosettes are presented in Plates 52 through 58. At midspan the theoretical bending moment is maximum and shear from both bending and torsion is zero, providing inequalities of torsion joint reactions and hanger bolt loads are negligible. Plates 52 through 55, which present the rosette data at midspan, agree well with beam theory. Gage I on the top cover shows high maximum principal stress (up to slightly over 10,000 psi tension) along the beam axis with small compression. Gage II on the bottom cover shows high minimum principal stress (up to about 10,000 psi compression) and virtually no tension. Rosettes K and L on the bending neutral axis both show all stresses to be very small as expected. Behavior of the rosettes at the end of the span under both bending and torsion and in the influence of the end joints cannot be readily predicted. Therefore, the results are presented in Plates 56 through 58 without comments on comparison of predicted behavior. For rosettes M and N, on the top and bottom covers respectively, the maximum principal stresses were approximately 2,000 psi tension and the minimum principal stresses were approximately 5,000 psi compression. Rosette O shows small stresses throughout with 3,000 psi tension as the maximum principal stress and numerically largest stress.

(5) There was too little consistency in the filar micrometer data to warrant its presentation in this report. This is attributed to the fact that the magnitudes of the motions measured were very small.

e. Two engineers, two engineering aides, one machinist, and one machine operator received sufficient instruction and practice to qualify them as fully trained operators of the 5,000,000 lb. capacity testing machine.

6. CONCLUSIONS

a. Investigation of the platform

It is concluded that the transverse loading platform of the 5,000,000 lb. machine can safely sustain a total machine load plus specimen weight of approximately 1,200,000 lb. over a working span up to 50 feet. It is concluded also that the data presented in this report as to bolt loads, deflections, and strains and stresses in the platform are representative of the general behavior of each item under normal symmetrical test conditions. (General behavior only is stated because the detailed behavior of each item of the complex built-up structure cannot be reproduced exactly at each loading.) Specifically, the representative behaviors are those presented as follows:

(1) Hanger Bolts - as presented in Table I and Plates 8 through 21.
(2) Torsion Joint Bolts - as presented in Table II and Plates 23 through 27.
(3) Deflections as presented in Table III and Plates 28 through 36 (with limitation that Plates 29 and 30 are not reliable).
(4) Strains and stresses as presented in Table IV and Plates 37 through 58.

As stated, these behaviors are only general. They are not to be used for working adjustments or corrections of test data and are not applicable under non-symmetrical test conditions. Therefore it is concluded that, in order to prevent possible overloading or overstraining of the hanger bolts (and thus the bedplate and/or platform also), precautions should be taken during tests involving high bolt loads (particularly if violent failures are expected).

b. Training of personnel

It is concluded that the six persons trained during performance of this work are as a result of this training fully qualified as operators of the 5,000,000 lb. testing machine.

7. RECOMMENDATIONS

a. Investigation of the platform. It is recommended that the transverse loading platform of the 5,000,000 lb. testing machine be used up to and including the capacities listed under conclusions (subject to the conditions listed below) and that the data listed under conclusions as being representative of the behavior of the platform be used to predict the general magnitudes to be expected under normal symmetrical test conditions. However, it is recommended that to prevent overloading or overstraining the hanger bolts (and thus the bedplate and/or platform also) special precautions be taken during the following tests:

(1) Symmetrical load tests in which the external platform load would exceed 900,000 lb., 75% of the total load capacity of 1,200,000 lb.

(2) Non-symmetrical tests in which the load in the heaviest loaded hanger bolt would exceed 90,000 lb., 75% of the limiting bolt capacity of 119,000 lb. determined in part "a" of Description.

The recommended special precautions are to read the strain gages on the hanger bolts in order to assure that the bolt strain or load limits are not exceeded and, except in case of proven necessity, not to run tests involving failure past the 75% limits. The arbitrary figure of 75% of platform capacity is chosen because it is a safe figure and also because the limiting figure for use of all the machines and both the transverse platforms in the laboratory is thus a uniform 75%. (Laboratory policy permits tests involving failure past 75% of machine capacity only if a larger machine is not available; reference (b) permits only non-failure tests past 75% of the 600,000 lb. machine platform capacity, these only if the larger platform is not available.)

b. Training of personnel. It is recommended that for subsequent training of personnel for this machine the outline of the training program reported herein be used as a guide.

HANGER BOLT STRAINS AND LOADS
TRANSVERSE LOADING PLATFORM
(5,000,000 LB. TESTING MACHINE)

Machine Load	Average Strain in Bolts											
	Bolt No. 1	Bolt No. 2	Bolt No. 3	Bolt No. 4	Bolt No. 5	Bolt No. 6	Bolt No. 7	Bolt No. 8	Bolt No. 9	Bolt No. 10	Bolt No. 11	Bolt No. 12
Kips	μin/in	μin/in	μin/in	μin/in	μin/in	μin/in	μin/in	μin/in	μin/in	μin/in	μin/in	μin/in
Bolts Unloaded	0	0	0	0	0	0	0	0	0	0	0	0
0*	52	206	242	235	175	46	38	167	243	226	188	48
100	76	231	279	279	223	80	76	197	278	257	235	85
200	121	275	321	322	274	128	130	238	311	290	276	131
300	171	305	350	350	312	180	181	271	347	323	312	179
400	230	344	381	381	355	236	238	309	377	356	344	235
500	276	369	397	400	378	281	277	335	396	371	372	276
600	319	397	420	424	409	330	325	366	418	392	405	325
700	385	434	450	452	448	385	379	400	446	420	440	377
800	427	462	469	474	472	431	422	429	465	439	466	423
900	483	492	490	486	495	471	470	458	485	457	495	465
1000	535	527	522	520	529	511	528	495	514	484	522	503
1100	558	540	529	531	542	533	553	513	526	493	538	525
0*	50	189	225	223	171	41	30	155	239	219	187	53
Bolts Unloaded	-1	-5	-5	0	-3	-4	-1	3	3	-2	4	0
Average Diameter (Ins)	3.038	3.032	3.033	3.038	3.041	3.040	3.042	3.027	3.039	3.031	3.036	3.040

Machine Load	Loads on Bolts												Total Load On Bolts
	Bolt No. 1	Bolt No. 2	Bolt No. 3	Bolt No. 4	Bolt No. 5	Bolt No. 6	Bolt No. 7	Bolt No. 8	Bolt No. 9	Bolt No. 10	Bolt No. 11	Bolt No. 12	
Kips	Kips	Kips	Kips	Kips	Kips	Kips	Kips	Kips	Kips	Kips	Kips	Kips	Kips
Bolts Unloaded	0	0	0	0	0	0	0	0	0	0	0	0	0
0*	10.9	43.1	50.7	49.4	36.8	9.7	8.0	34.8	51.1	47.3	39.5	10.1	391.4
100	16.0	48.4	58.4	58.6	46.9	16.8	16.0	41.1	58.5	53.8	49.3	17.9	481.7
200	25.4	57.6	67.2	67.7	57.7	26.9	27.4	49.6	65.4	60.7	57.9	27.6	591.1
300	35.9	63.9	73.3	73.6	65.7	37.9	38.2	56.5	73.0	67.6	65.5	37.7	688.8
400	48.3	72.0	79.8	80.1	74.8	49.7	50.2	64.5	79.3	74.5	72.2	49.4	794.8
500	58.0	77.3	83.2	84.1	79.6	59.2	58.4	69.9	83.3	77.6	78.1	58.1	866.8
600	67.0	83.1	88.0	89.1	86.1	69.5	68.5	76.4	87.9	82.0	85.0	68.4	951.0
700	80.9	90.9	94.2	95.0	94.3	81.0	79.9	83.4	93.8	87.8	92.3	79.3	1052.8
800	89.7	96.7	98.2	99.6	99.4	90.7	88.9	89.5	97.8	91.8	97.8	89.0	1129.1
900	101.5	103.0	102.6	102.2	104.2	99.1	99.1	95.6	102.0	95.6	103.9	97.8	1206.6
1000	112.4	110.3	109.3	109.3	111.4	107.6	111.3	103.3	108.1	101.2	109.6	105.8	1299.6
1100	117.3	113.1	110.8	111.6	114.1	112.2	116.6	107.0	110.6	103.1	112.9	110.5	1339.8
0*	10.5	39.6	47.1	46.9	36.0	8.6	6.3	32.3	50.3	45.8	39.2	11.2	373.8
Bolts Unloaded	-0.2	-1.0	-1.0	0	-0.6	-0.8	-0.2	0.6	0.6	-0.4	0.8	0	-2.2

* Although no machine load, specimen resting on platform

Specification Modulus of Elasticity (E) = 29×10^6 psi

Measured ultimate strength = 106,000 psi minimum (by Brinell Hardness Test)

Assumed yield strength = 53,000 psi (= 1/2 ultimate strength)

Yield strain = 1825 micro inches per inch (μ in/in)

TORSION JOINT BOLT STRAINS AND LOADS

TRANSVERSE LOADING PLATFORM
5,000,000 LB. TESTING MACHINE

Machine Load	Average Strain in Bolts								Loads on Bolts							
	Bolt No. I	Bolt No. II	Bolt No. III	Bolt No. IV	Bolt No. V	Bolt No. VI	Bolt No. VII	Bolt No. VIII	Bolt No. I	Bolt No. II	Bolt No. III	Bolt No. IV	Bolt No. V	Bolt No. VI	Bolt No. VII	Bolt No. VIII
Kips	μ in/in	μ in/in	μ in/in	μ in/in	μ in/in	μ in/in	μ in/in	μ in/in	Kips	Kips	Kips	Kips	Kips	Kips	Kips	Kips
Bolts Unloaded	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0* (bolts preloaded)	180	190	200	197	185	178	188	196	26.7	28.2	30.0	29.0	27.4	26.2	28.1	28.8
100	209	204	216	227	214	196	205	225	31.0	30.3	32.4	33.5	31.7	28.8	30.7	33.1
200	238	220	239	259	244	217	225	252	35.3	32.7	35.9	38.2	36.1	31.9	33.6	37.0
300	264	233	261	290	270	234	238	279	39.1	34.6	39.2	42.7	40.0	34.4	35.6	41.0
400	291	242	275	312	294	249	252	302	43.1	35.9	41.3	46.0	43.5	36.6	37.7	44.4
500	321	256	299	349	323	269	269	329	47.6	38.0	44.9	51.4	47.8	39.6	40.2	48.3
600	346	266	313	374	347	283	279	352	51.3	39.5	47.0	55.1	51.4	41.6	41.7	51.7
700	377	277	330	402	373	298	292	377	55.9	41.1	49.6	59.2	55.2	43.9	43.7	55.4
800	401	289	351	431	401	316	307	405	59.4	42.9	52.7	63.5	59.4	46.5	45.9	59.5
900	427	301	374	460	429	331	319	429	63.3	44.7	56.2	67.8	63.5	48.7	47.7	63.0
1000	449	311	380	478	448	340	332	449	66.5	46.2	57.1	70.4	66.3	50.0	49.6	66.0
1100	467	319	391	493	461	350	340	464	69.2	47.3	58.7	72.6	68.3	51.5	50.8	68.2
0*	188	199	214	209	200	194	196	203	27.9	29.5	32.1	30.8	29.6	28.5	29.3	29.8
Average Width (ins)	2.261	2.262	2.276	2.254	2.260	2.253	2.271	2.251								

* Although no machine load, specimen resting on platform

Specification Modulus of Elasticity (E) = 29×10^6 psi
Measured Ultimate Strength = 74,000 psi minimum (by Brinell Hardness Test)
Assumed Yield Strength = 37,000 psi (1/2 ultimate strength)
Yield Strain = 1275 μ in/inch

TABLE II

DIAL GAGE DEFLECTIONS

TRANSVERSE LOADING PLATFORM
(5,000,000 LB. TESTING MACHINE)

Machine Load	Deflections																			
	Gage No. 1	Gage No. 2	Gage No. 3	Gage No. 4	Gage No. 5	Gage No. 6	Gage No. 7	Gage No. 8	Gage No. 9	Gage No. 10	Gage No. 11	Gage No. 12	Gage No. 13	Gage No. 14	Gage No. 15	Gage No. 16	Gage No. 17	Gage No. 18	Gage No. 19	Gage No. 20
Kips	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
*0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
100	.004	-.017	.008	.008	.010	.015	.029	.033	.015	.025	.009	.022	.000	.007	.043	.050	.066	.085	.085	.044
200	.011	.003	.012	.014	.018	.026	.060	.069	.031	.051	.015	.044	.006	.053	.078	.090	.137	.165	.156	.084
300	.019	.006	.016	.019	.024	.032	.090	.103	.043	.076	.021	.063	.018	.079	.113	.128	.206	.224	.225	.118
400	.028	.006	.019	.025	.028	.040	.121	.140	.057	.102	.028	.083	.028	.107	.146	.163	.280	.326	.298	.156
500	.038	.006	.023	.030	.030	.048	.153	.177	.072	.127	.033	.102	.039	.131	.179	.198	.354	.408	.368	.191
600	.047	.011	.026	.037	.036	.056	.185	.213	.086	.151	.040	.122	.051	.155	.211	.235	.424	.487	.438	.225
700	.057	.022	.029	.042	.043	.064	.215	.228	.103	.176	.045	.141	.062	.180	.242	.271	.495	.568	.508	.259
800	.068	.023	.033	.047	.050	.072	.248	.285	.119	.201	.051	.160	.077	.204	.274	.306	.567	.668	.577	.293
900	.076	.024	.037	.050	.056	.080	.279	.320	.133	.225	.056	.179	.090	.226	.302	.339	.640	.726	.640	.325
1000	.082	.027	.040	.051	.059	.084	.305	.348	.143	.244	.059	.193	.098	.242	.321	.361	.696	.791	.695	.346
1100	.083	.026	.039	.051	.060	.086	.317	.363	.145	.254	.060	.201	.104	.256	.337	.380	.738	.848	.749	.364
0*	.000	.007	.002	.001	.003	.005	.005	.007	.004	.009	.003	.010	.000	.012	.016	.019	-.010	-.016	.016	-.024

* Although no machine load, specimen resting on platform

STRAINS AND STRESSES FOR ROSETTES A, A', B, C, D AND E (SEE PAGE 4 FOR SYMBOLS EXPLANATION)

Gage	Symb	LOAD (KIPS) 0	100	200	300	400	500	600	700	800	900	1000	1100
A	ϵ_a	0	5	10	15	5	5	5	15	15	15	20	20
	ϵ_b	0	20	40	55	65	85	100	120	140	155	180	195
	ϵ_c	0	0	10	10	0	5	10	10	15	15	20	20
	ϵ_1	0	21	40	56	66	87	102	122	142	158	183	198
	ϵ_2	0	-16	-21	-31	-62	-77	-87	-98	-113	-128	-144	-159
	γ	0	18	31	44	64	82	95	110	128	143	164	179
	σ_1	0	.50	1.09	1.48	1.50	2.00	2.38	2.93	3.42	3.76	4.41	4.75
	σ_2	0	-.29	-.25	-.42	-1.29	-1.57	-1.75	-1.87	-2.15	-2.49	-2.72	-3.05
	τ	0	.39	.67	.95	1.39	1.78	2.06	2.40	2.79	3.12	3.57	3.90
	α	0	41	45	43	44	45	46	44	45	45	45	45
A'	ϵ_a	0	0	0	0	-10	-10	-15	-15	-15	-15	-15	-15
	ϵ_b	0	20	45	70	80	100	120	140	160	185	205	230
	ϵ_c	0	0	5	10	0	5	10	10	15	20	20	25
	ϵ_1	0	20	46	72	82	103	123	144	164	190	210	236
	ϵ_2	0	-20	-41	-62	-92	-107	-128	-149	-164	-185	-205	-226
	γ	0	20	44	67	87	105	126	146	164	187	208	231
	σ_1	0	.45	1.06	1.67	1.69	2.18	2.64	3.08	3.58	4.19	4.64	5.25
	σ_2	0	-.45	-.84	-1.24	-2.11	-2.40	-2.85	-3.29	-3.58	-3.98	-4.42	-4.82
	τ	0	.45	.95	1.45	1.90	2.29	2.74	3.19	3.58	4.09	4.53	5.03
	α	0	45	47	47	47	47	48	48	48	48	48	48
B	ϵ_a	0	0	0	0	0	5	5	5	10	10	10	20
	ϵ_b	0	0	5	10	20	20	30	40	45	50	60	70
	ϵ_c	0	0	5	5	5	5	5	15	20	20	25	30
	ϵ_1	0	0	6	11	21	20	30	41	46	51	61	71
	ϵ_2	0	0	-1	-6	-16	-10	-21	-21	-16	-21	-27	-22
	γ	0	0	4	8	18	15	26	31	31	36	44	46
	σ_1	0	0	.19	.28	.50	.55	.77	1.10	1.31	1.42	1.70	2.07
	σ_2	0	0	-.03	-.07	-.29	-.12	-.35	-.23	-.04	-.15	-.22	-.05
	τ	0	0	.08	.18	.39	.33	.56	.68	.68	.79	.96	1.01
	α	0	0	68	54	49	45	45	50	50	49	50	48

Gage	Symb	LOAD (KIPS) 0	100	200	300	400	500	600	700	800	900	1000	1100
C	ϵ_a	0	-5	5	5	5	10	15	10	10	15	25	20
	ϵ_b	0	0	5	10	10	25	30	20	30	30	35	40
	ϵ_c	0	0	-10	0	-5	0	0	0	5	0	0	5
	ϵ_1	0	1	8	11	11	26	32	21	30	32	39	41
	ϵ_2	0	-6	-13	-6	-11	-16	-17	-11	-16	-17	-14	-17
	γ	0	4	11	8	11	21	24	16	23	24	26	29
	σ_1	0	.03	.13	.28	.25	.67	.85	.56	.82	.85	1.10	1.16
	σ_2	0	-.19	-.34	-.07	-.25	-.25	-.21	-.14	-.19	-.21	-.05	-.11
	τ	0	.08	.24	.18	.25	.46	.53	.35	.50	.53	.57	.64
	α	0	113	158	144	148	142	144	144	138	144	150	143
D	ϵ_a	0	10	10	10	10	10	10	10	10	20	30	25
	ϵ_b	0	5	15	10	5	15	15	25	35	45	55	55
	ϵ_c	0	5	5	5	-5	-5	-5	0	-5	5	5	5
	ϵ_1	0	11	15	11	11	17	17	26	37	46	58	57
	ϵ_2	0	4	-1	4	-6	-12	-12	-16	-32	-22	-23	-27
	γ	0	4	8	4	8	15	15	21	34	34	40	42
	σ_1	0	.40	.49	.40	.28	.43	.43	.67	.85	1.27	1.62	1.55
	σ_2	0	.24	.14	.24	-.07	-.22	-.22	-.25	-.64	-.21	-.74	-.28
	τ	0	.08	.18	.08	.18	.33	.33	.46	.74	.74	.88	.92
	α	0	158	36	23	9	30	30	38	39	39	36	38
E	ϵ_a	0	0	0	0	-10	-5	-5	0	-5	0	-5	-5
	ϵ_b	0	0	10	15	10	15	15	20	25	30	30	35
	ϵ_c	0	5	10	10	0	5	0	0	5	10	10	10
	ϵ_1	0	6	12	16	11	16	16	20	26	31	32	37
	ϵ_2	0	-1	-2	-7	-21	-16	-21	-20	-26	-21	-27	-32
	γ	0	4	7	11	16	16	18	20	26	26	29	34
	σ_1	0	.19	.37	.46	.14	.35	.29	.45	.57	.78	.74	.85
	σ_2	0	.03	.05	-.04	-.56	-.35	-.50	-.45	-.57	-.36	-.53	-.64
	τ	0	.08	.16	.25	.35	.35	.39	.45	.57	.57	.64	.74
	α	0	113	68	58	54	54	49	45	51	51	53	52

STRAINS AND STRESSES FOR ROSETTES F, F', G, G', H, H' (SEE PAGE 4 FOR SYMBOLS EXPLANATION)

Gage	Symbol	LOAD (KIPS) 0	100	200	300	400	500	600	700	800	900	1000	1100
F	ϵ_a	0	-20	-30	-40	-55	-60	-80	-90	-95	-105	-120	-130
	ϵ_b	0	10	20	35	50	65	85	100	120	130	150	170
	ϵ_c	0	5	0	5	10	10	15	20	25	30	35	45
	ϵ_1	0	17	27	43	61	73	96	112	129	141	163	184
	ϵ_2	0	-32	-57	-77	-105	-122	-160	-181	-198	-215	-246	-267
	γ	0	24	42	60	83	97	128	146	163	178	205	225
	σ_1	0	.21	.28	.56	.85	1.06	1.42	1.71	2.08	2.29	2.66	3.11
	σ_2	0	-.85	-1.60	-2.05	-2.75	-3.18	-4.17	-4.70	-5.04	-5.50	-6.26	-6.71
	τ	0	.53	.92	1.30	1.80	2.12	2.80	3.20	3.56	3.90	4.50	4.91
	α	0	63	57	57	57	56	56	56	56	56	56	56
F'	ϵ_a	0	-10	-20	-30	-35	-45	-45	-55	-60	-75	-75	-85
	ϵ_b	0	20	35	50	70	90	105	130	150	170	190	210
	ϵ_c	0	10	10	15	20	25	40	45	50	55	60	70
	ϵ_1	0	23	39	56	77	99	116	142	163	186	206	229
	ϵ_2	0	-23	-49	-70	-91	-118	-121	-152	-173	-205	-221	-243
	γ	0	23	44	63	84	108	118	147	168	196	213	236
	σ_1	0	.50	.74	1.06	1.52	1.94	2.47	3.00	3.45	3.84	4.33	4.83
	σ_2	0	-.50	-1.16	-1.70	-2.15	-2.78	-2.68	-3.42	-3.90	-4.70	-4.97	-5.50
	τ	0	.50	.95	1.38	1.83	2.36	2.58	3.21	3.67	4.27	4.65	5.15
	α	0	58	55	56	55	55	56	55	55	55	54	55
G	ϵ_a	0	0	0	0	0	5	10	5	10	10	10	15
	ϵ_b	0	10	30	50	70	85	110	130	155	175	195	215
	ϵ_c	0	0	-5	-5	-5	-5	0	5	5	5	5	5
	ϵ_1	0	10	31	51	72	87	112	133	158	179	199	210
	ϵ_2	0	-10	-36	-56	-77	-87	-103	-123	-143	-164	-184	-200
	γ	0	10	33	54	74	87	107	128	151	171	192	210
	σ_1	0	.22	.62	1.07	1.51	1.90	2.60	3.00	3.60	4.10	4.50	5.00
	σ_2	0	-.22	-.83	-1.30	-1.72	-1.90	-2.13	-2.60	-3.00	-3.42	-3.90	-4.15
	τ	0	.22	.73	1.17	1.62	1.90	2.34	2.79	3.29	3.73	4.18	4.57
	α	0	45	43	44	44	43	44	45	45	45	45	44

Gage	Symbol	LOAD (KIPS) 0	100	200	300	400	500	600	700	800	900	1000	1100
G'	ϵ_a	0	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	0
	ϵ_b	0	15	35	50	70	85	105	130	145	170	185	205
	ϵ_c	0	0	0	-5	-5	-5	-5	-10	-10	-10	-10	-10
	ϵ_1	0	16	36	51	72	87	108	133	149	174	189	210
	ϵ_2	0	-21	-41	-61	-82	-97	-117	-148	-163	-189	-204	-220
	γ	0	18	38	56	77	92	112	141	156	181	197	215
	σ_1	0	.29	.73	1.01	1.50	1.80	2.24	2.80	3.10	3.64	3.97	4.50
	σ_2	0	-.50	-.94	-1.44	-1.90	-2.22	-2.70	-3.40	-3.72	-4.30	-4.61	-4.90
	τ	0	.39	.84	1.23	1.70	2.01	2.45	3.07	3.40	3.96	4.30	4.70
	α	0	49	47	45	45	45	45	45	45	45	45	44
H	ϵ_a	0	-5	-5	-5	-15	-20	-15	-15	-15	-20	-20	-20
	ϵ_b	0	15	40	55	65	85	105	135	155	175	195	215
	ϵ_c	0	0	-5	0	0	5	0	5	10	15	15	25
	ϵ_1	0	16	41	56	67	88	108	139	159	180	200	221
	ϵ_2	0	-21	-51	-61	-82	-103	-123	-148	-164	-185	-205	-216
	γ	0	18	46	59	75	95	115	143	162	182	203	218
	σ_1	0	.29	.79	1.18	1.31	1.76	2.20	2.97	3.42	3.87	4.31	4.87
	σ_2	0	-.50	-1.22	-1.39	-1.94	-2.40	-2.83	-3.34	-3.63	-4.08	-4.52	-4.66
	τ	0	.39	1.00	1.28	1.62	2.08	2.51	3.13	3.52	3.98	4.42	4.76
	α	0	49	45	46	48	49	47	47	47	48	48	48
H'	ϵ_a	0	-5	0	5	-5	-10	-5	-5	0	0	0	0
	ϵ_b	0	25	40	60	75	85	115	130	155	170	195	210
	ϵ_c	0	0	0	5	0	0	5	5	10	10	10	20
	ϵ_1	0	26	41	61	77	87	118	133	158	174	199	214
	ϵ_2	0	-31	-41	-51	-82	-97	-118	-133	-149	-164	-189	-195
	γ	0	28	41	56	79	92	118	133	153	169	194	205
	σ_1	0	.51	.89	1.44	1.62	1.80	2.57	2.90	3.56	3.90	4.45	4.90
	σ_2	0	-.72	-.89	-1.01	-1.83	-2.22	-2.57	-2.90	-3.13	-3.47	-4.02	-4.04
	τ	0	.62	.89	1.23	1.73	2.01	2.57	2.90	3.34	6.68	4.24	4.46
	α	0	48	45	45	46	47	46	46	46	46	46	47

TABLE IV

STRAINS AND STRESSES FOR ROSETTES I, J, K, L, M, N (SEE PAGE 4 FOR SYMBOLS EXPLANATION)

Gage	Symbol	LOAD (KIPS) 0	100	200	300	400	500	600	700	800	900	1000	1100
	ϵ_a	0	30	65	100	135	170	200	235	260	300	320	340
	ϵ_b	0	10	30	50	65	90	90	115	130	150	160	160
	ϵ_c	0	-20	-20	-30	-30	-45	-50	-55	-60	-60	-70	-80
	ϵ_1	0	31	66	102	137	175	202	238	264	304	324	344
I	ϵ_2	0	-21	-22	-34	-36	-52	-55	-62	-69	-69	-80	-90
	γ	0	26	44	68	85	113	129	150	166	187	202	217
	σ_1	0	.78	1.91	2.97	4.08	5.12	5.98	7.09	7.86	9.14	9.70	10.23
	σ_2	0	-.36	-.01	-.01	.36	.17	.37	.53	.60	1.01	.88	.77
	τ	0	.57	.96	1.49	1.86	2.47	2.81	3.28	3.63	4.07	4.41	4.73
	α	0	6	5	7	4	7	3	5	5	5	5	4
	ϵ_a	0	-40	-70	-100	-130	-160	-200	-230	-270	-295	-320	-340
	ϵ_b	0	-20	-30	-30	-40	-50	-60	-65	-80	-80	-90	-90
	ϵ_c	0	10	20	30	45	55	60	75	85	100	100	110
	ϵ_1	0	11	22	32	48	59	65	81	91	107	108	119
J	ϵ_2	0	-41	-71	-101	-131	-161	-202	-232	-272	-298	-323	-344
	γ	0	26	46	67	89	110	133	157	182	203	216	231
	σ_1	0	-.07	-.05	-.03	.15	.17	-.06	.13	.05	.29	.05	.18
	σ_2	0	-1.20	-2.07	-2.93	-3.75	-4.62	-5.87	-6.69	-7.88	-8.54	-9.36	-9.91
	τ	0	.57	1.01	1.45	1.95	2.40	2.91	3.41	3.97	4.42	4.70	5.05
	α	0	96	93	88	89	89	88	88	88	88	87	87
	ϵ_a	0	-5	-5	-5	-5	-5	-5	0	-5	-5	-5	-5
	ϵ_b	0	-5	-5	5	5	5	5	5	5	5	5	10
	ϵ_c	0	-10	-10	0	5	10	0	10	0	10	10	10
	ϵ_1	0	-4	-4	6	7	11	6	10	6	11	11	13
K	ϵ_2	0	-11	-11	-11	-7	-6	-11	0	-11	-6	-6	-8
	γ	0	4	4	8	7	8	8	5	8	8	8	11
	σ_1	0	-.24	-.24	.07	.16	.28	.27	.33	.07	.28	.28	.34
	σ_2	0	-.40	-.40	-.28	-.16	-.07	-.28	.10	-.28	-.07	-.07	-.13
	τ	0	.08	.08	.18	.16	.18	.18	.11	.18	.18	.18	.24
	α	0	158	158	126	135	99	126	270	126	99	99	135

Gage	Symb	LOAD (KIPS) 0	100	200	300	400	500	600	700	800	900	1000	1100
	ϵ_a	0	0	-10	-10	-10	-10	-20	-15	-20	-20	-25	-25
	ϵ_b	0	-5	-15	-25	-20	-25	-25	-25	-30	-30	-30	-35
	ϵ_c	0	0	-10	-10	-10	-10	-15	-10	-20	-15	-15	-15
	ϵ_1	0	5	-5	6	0	6	-9	1	-9	-4	-8	-3
L	ϵ_2	0	-5	-15	-25	-20	-25	-25	-25	-30	-30	-30	-36
	γ	0	5	5	15	10	15	8	13	10	13	11	16
	σ_1	0	.11	-.31	-.09	-.20	-.09	-.57	-.25	-.62	-.46	-.60	-.50
	σ_2	0	-.11	-.53	-.76	-.65	-.76	-.92	-.81	-1.07	-1.03	-1.10	-1.20
	τ	0	.11	.11	.33	.22	.33	.18	.28	.22	.28	.25	.35
	α	0	45	45	45	45	45	54	51	45	51	58	54
	ϵ_a	0	5	-5	0	-5	0	0	0	-5	-5	0	0
	ϵ_b	0	10	0	10	10	20	20	20	30	30	40	40
	ϵ_c	0	-20	-30	-40	-50	-55	-70	-80	-90	-100	-110	-110
	ϵ_1	0	15	5	17	18	29	32	39	44	46	58	58
	ϵ_2	0	-29	-39	-56	-72	-83	-101	-117	-137	-149	-166	-166
M	γ	0	22	22	37	45	56	67	78	90	97	112	112
	σ_1	0	.16	-.26	.04	-.19	.06	-.03	.01	-.04	-.10	.12	.12
	σ_2	0	-.80	-1.22	-1.70	-2.14	-2.40	-2.94	-3.40	-3.98	-4.34	-4.77	-4.77
	τ	0	.48	.48	.80	.97	1.22	1.45	1.71	1.97	2.12	2.45	2.45
	α	0	27	27	28	30	30	29	28	31	31	30	30
	ϵ_a	0	-10	-20	-20	-20	-30	-45	-40	-60	-60	-65	-70
	ϵ_b	0	-25	-45	-55	-65	-90	-105	-125	-150	-165	-175	-185
	ϵ_c	0	-10	-10	-10	0	0	0	0	-10	0	0	-10
	ϵ_1	0	6	16	27	47	64	65	90	86	112	118	112
N	ϵ_2	0	-25	-46	-56	-67	-93	-109	-129	-155	-171	-181	-190
	γ	0	15	31	41	57	78	87	109	120	141	149	151
	σ_1	0	-.09	.04	.26	.82	1.07	.95	1.54	1.14	1.81	1.88	1.61
	σ_2	0	-.76	-1.31	-1.33	-1.67	-2.34	-2.86	-3.23	-4.10	-4.35	-4.63	-4.99
	τ	0	.33	.68	.90	1.25	1.71	1.91	2.38	2.62	3.08	3.26	3.30
	α	0	135	130	132	130	129	127	130	129	129	129	129

TABLE IV

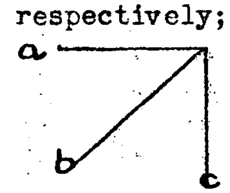
STRAINS AND STRESSES FOR ROSETTE O

Gage	Symbol	LOAD (KIPS) 0	100	200	300	400	500	600	700	800	900	1000	1100
O	ϵ_a	0	0	10	10	20	25	25	30	30	30	40	40
	ϵ_b	0	10	20	30	40	50	60	70	80	80	90	100
	ϵ_c	0	0	0	5	10	5	0	10	0	10	10	10
	ϵ_1	0	10	25	33	45	61	74	81	96	91	106	116
	ϵ_2	0	-10	-16	-18	-16	-31	-49	-42	-67	-52	-57	-67
	γ	0	10	20	26	31	46	61	61	82	72	82	92
	σ_1	0	.22	.66	.88	1.31	1.64	1.87	2.19	2.42	2.41	2.84	3.06
	σ_2	0	-.22	-.23	-.24	-.04	-.37	-.81	-.49	-1.15	-.71	-.72	-.94
	τ	0	.22	.44	.56	.67	1.00	1.34	1.34	1.78	1.56	1.78	2.00
	α	0	135	144	138	141	143	142	141	142	140	142	141

Explanation of Strain Gage Data

Rosettes:

ϵ_a, ϵ_b, ϵ_c : Net strain readings for individual rosette gages a, b, c respectively; microinches per inch.



ϵ_1 Maximum Principal Strain; microinches per inch.
ϵ_2 Minimum Principal Strain; microinches per inch.
γ Maximum Shear Strain; microinches per inch.
σ_1 Maximum Principal Stress; kips per square inch.
σ_2 Minimum Principal Stress; kips per square inch.
τ Maximum Shear Stress; kips per square inch.
α Direction of Maximum Principal Stress measured from axis of horizontal rosette gage a, in degrees positive counter clockwise:
Observer faces north to view Rosettes A, A', B, C, K, L, O
Observer faces west to view Rosettes D, E, F, F', G, G', H, H'
Observer faces north and looks down to view Rosettes I, J, M, N

Single Strain Gages:

Stresses were computed from original strain data using formula: Stress = Ex strain
To convert stress to strain, divide stress by 29×10^6 psi

Physical Constants Used in Calculations

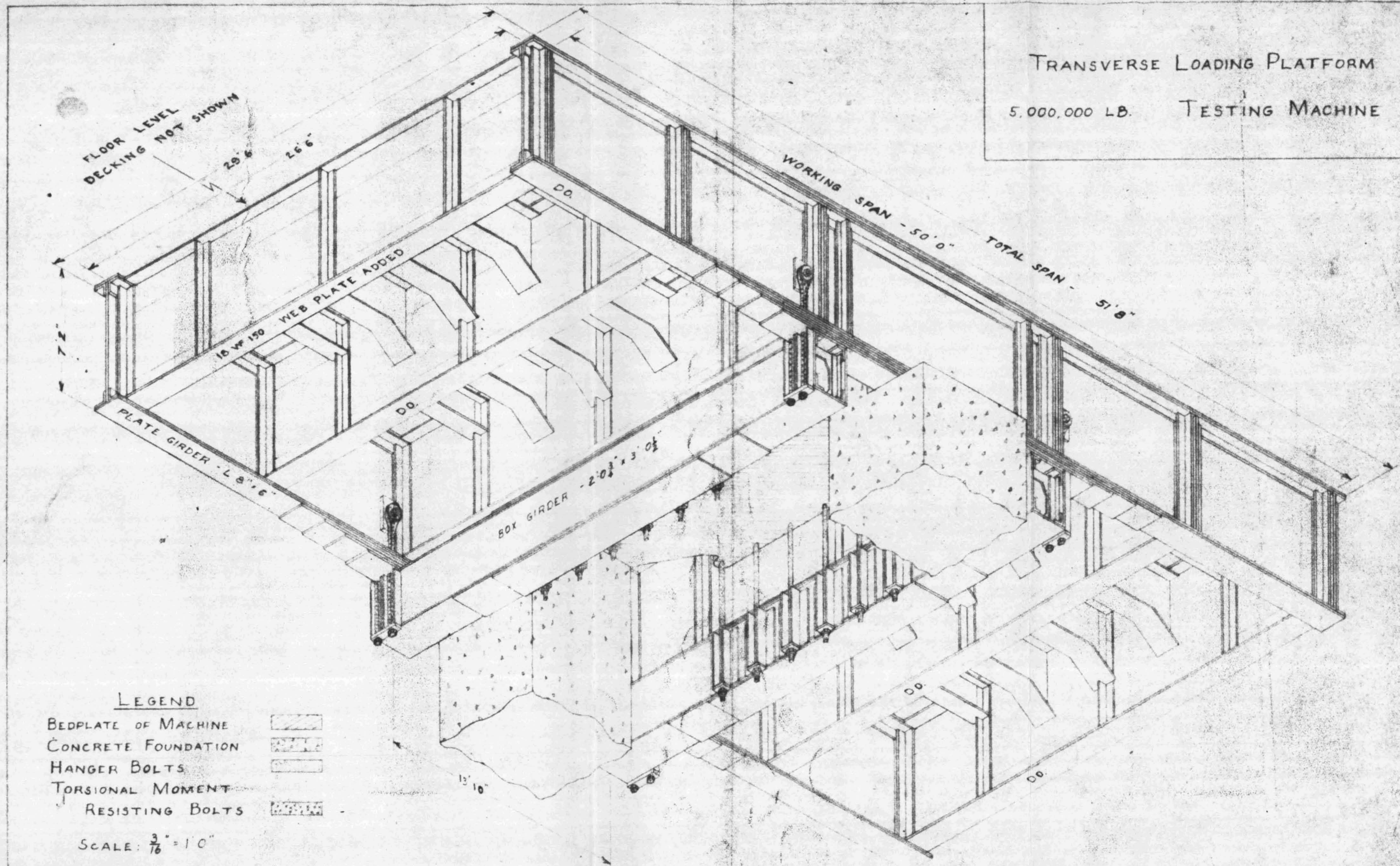
Poisson's ratio (ν) = .33
Modulus of Elasticity (E) = 29×10^6 psi
Correction factor for transverse sensitivity of rosette gages = 45

STRESSES FOR SINGLE STRAIN GAGES

Gage	LOAD (KIPS) 0	100	200	300	400	500	600	700	800	900	1000	1100
a	0	.73	1.60	2.32	2.90	3.63	4.50	5.51	6.24	7.11	7.98	8.85
b	0	.15	.44	.87	1.02	1.31	1.60	1.89	2.18	2.47	2.76	3.34
c	0	0	0	0	0	.15	.29	.29	.29	.29	.58	.29
d	0	-.29	0	0	-.15	-.29	-.15	0	0	0	.15	.29
e	0	-.15	.15	-.15	-.44	-.44	-.44	-.58	-.73	-.44	-.58	-.73
f	0	0	.15	0	-.15	-.15	-.15	0	.58	.29	.44	.29
g	0	-.58	-1.02	-1.31	-1.74	-2.32	-2.61	-2.90	-3.34	-3.77	-4.06	-4.21
h	0	.58	1.16	1.74	2.03	2.61	2.90	3.63	4.06	4.64	5.22	5.51
i	0	.73	1.16	1.60	1.74	2.18	2.90	3.34	3.19	3.63	4.35	4.64
j	0	-.15	-.15	-.29	-.29	-.29	-.29	-.29	-.44	-.29	-.44	-.29
k	0	-.58	-1.31	-1.74	-2.32	-2.90	-3.48	-3.92	-4.50	-5.08	-5.66	-6.09
l	0	0	-.29	-.29	-.44	-.58	-.87	-.87	-1.16	-1.45	-1.60	-1.74
l'	0	0	0	0	.29	.29	.29	.29	.29	.29	.29	.29
m	0	.44	.73	1.02	1.45	1.89	2.18	2.47	2.47	2.76	2.90	3.05
n	0	.29	.44	.73	.58	.58	.44	.44	.44	.29	.15	.29
n'	0	0	-.29	-.44	-.73	-.87	-1.02	-1.16	-1.45	-1.74	-1.74	-2.03
o	0	.29	.58	.87	1.02	1.45	1.74	2.18	2.47	2.61	2.90	2.90
o'	0	.52	.87	1,45	1.89	2.32	2.90	3.48	3.77	4.35	4.64	4.93
p	0	-.44	-1.16	-1.74	-2.18	-2.90	-3.48	-3.92	-4.64	-5.37	-5.95	-6.38
q	0	-.87	-1.89	-2.90	-3.48	-4.35	-5.22	-5.80	-6.67	-7.4	-7.98	-8.41
r	0	-.87	-1.74	-2.61	-3.34	-4.06	-4.93	-5.51	-6.38	-7.25	-7.83	-8.27
s	0	.15	0	0	0	0	0	.15	0	0	0	-.15
t	0	-.58	-.87	-1.16	-1.45	-1.60	-2.03	-2.18	-2.47	-2.90	-3.05	-3.19
u	0	-.58	-1.31	-1.74	-2.32	-2.61	-3.48	-3.77	-4.35	-4.79	-5.08	-5.51
v	0	-1.16	-1.74	-2.90	-3.19	-3.77	-4.64	-5.51	-6.38	-6.96	-7.40	-7.83
w	0	-.87	-1.74	-2.32	-2.90	-3.77	-4.35	-4.93	-5.80	-6.38	-6.96	-6.96

TRANSVERSE LOADING PLATFORM

5,000,000 LB. TESTING MACHINE



LEGEND

BEDPLATE OF MACHINE

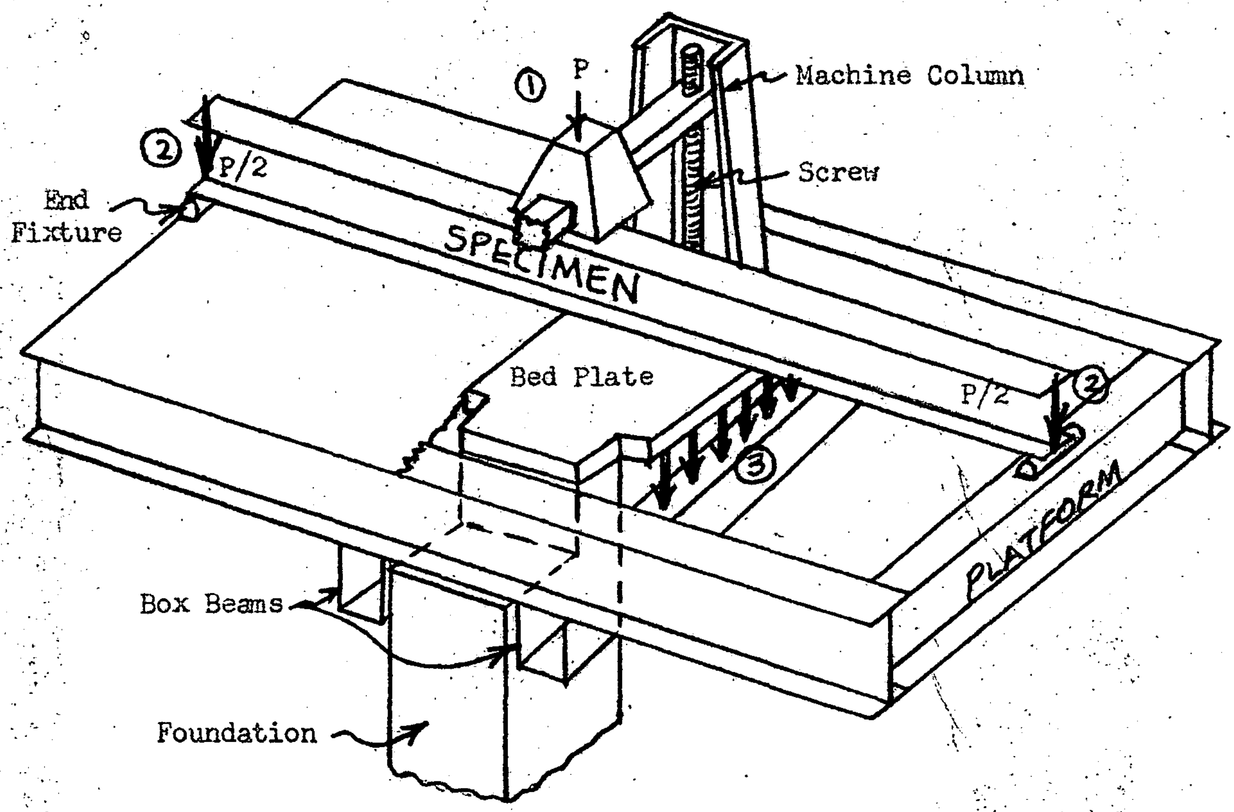
CONCRETE FOUNDATION

HANGER BOLTS

TORSIONAL MOMENT RESISTING BOLTS

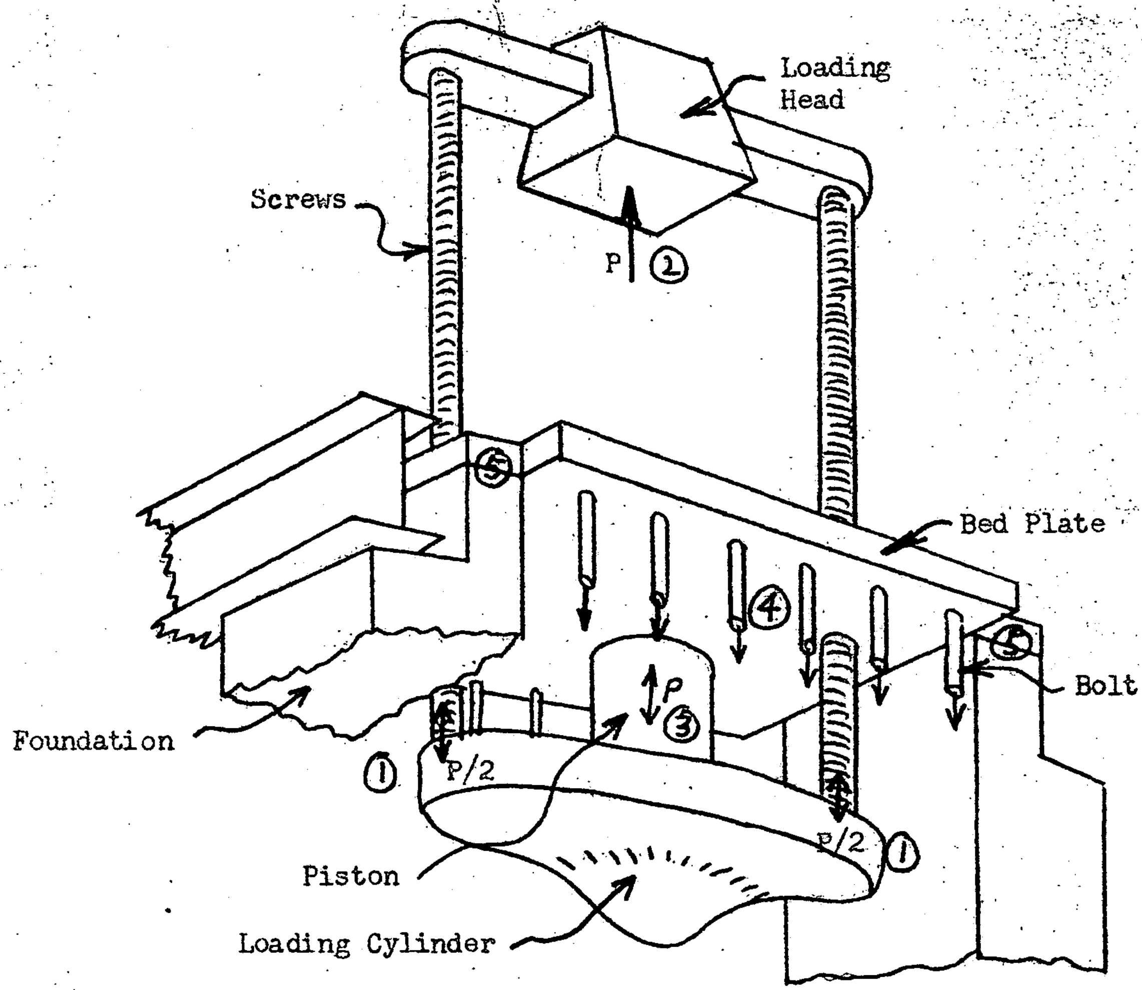
SCALE: $\frac{3}{16}$" = 1'0"

PLATE 1



OPERATION OF TRANSVERSE LOADING PLATFORM
OF 5,000,000 LBS. CAPACITY TESTING MACHINE

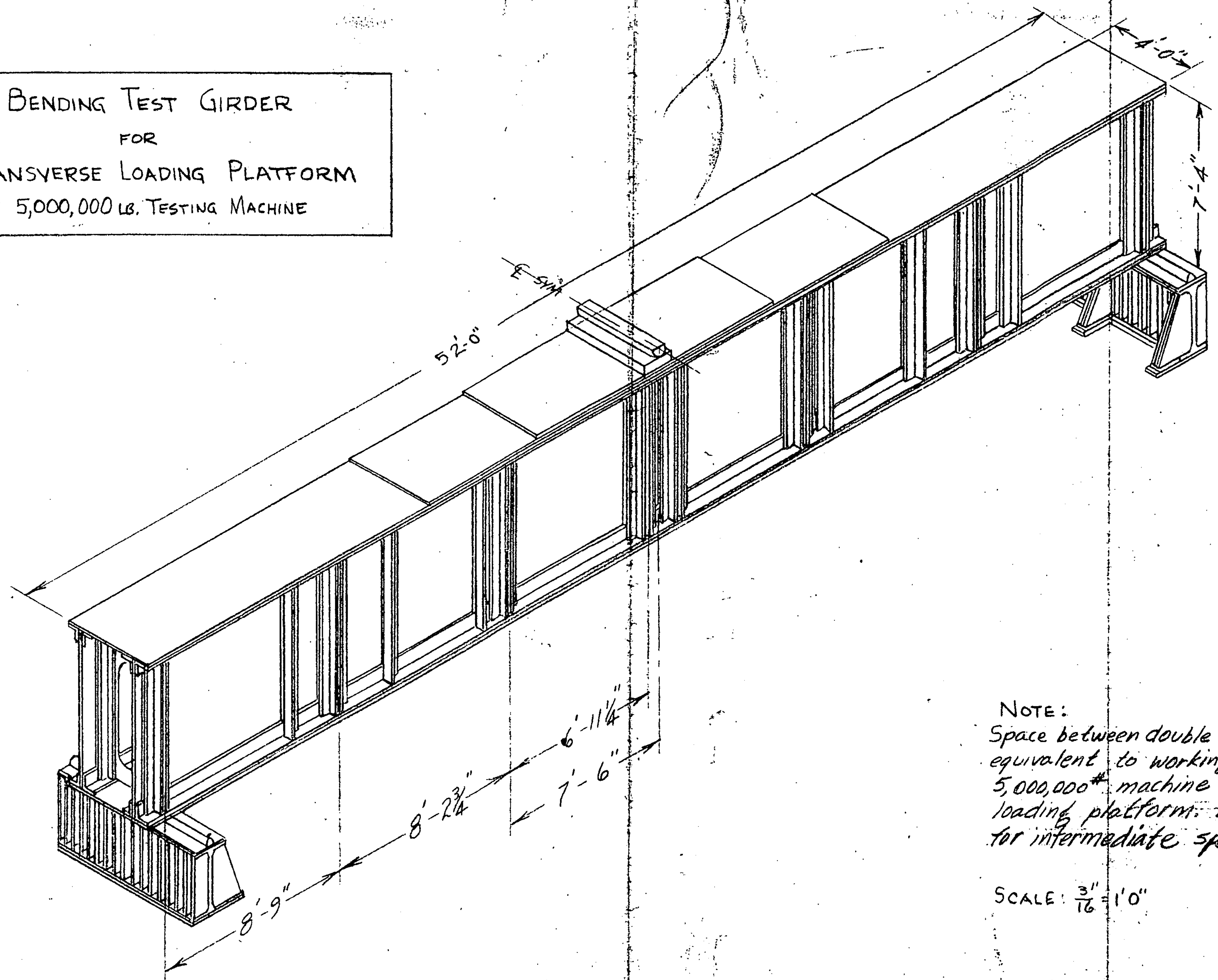
At 1 machine applies load P to center of specimen.
At 2 the specimen loads each end fixture with load P/2 plus $W_2/2$. (W_2 is specimen weight).
At 3 platform hangs from bedplate of machine by twelve bolts, and pulls down with total load equal to the two loads at 2 plus the platform weight (W_3). Total load at 3 is $P + W_2 + W_3$.
If specimen were reacted onto floor without a platform, the loads at 3 would not exist.



REACTING OF BENDING SPECIMEN LOADS IN THE
5,000,000 LBS. TESTING MACHINE

At ① loading cylinder pulls downward on screws with total load P. Screws transmit load to loading head of machine.
At ② loading head applies load P to specimen, so specimen reacts on loading head with upward load P.
At ③, in exerting down load P on the screws the cylinder exerts (via the hydraulic oil) an up load P through the piston to the bedplate of the machine.
At ④, the transverse platform is attached to the bed plate by twelve bolts. The bolts pull down with a total load (see plate 22) of P plus specimen wt. (W_2) plus platform wt. (W_3).
At ⑤ the machine wt (W_1) rests on the foundation. (a) with the platform, the load on foundation is $W_1 + W_2 + W_3$. (b) with specimen reacted onto floor without platform (no load on bolts at ④), load on the foundation is $W_1 - P$.

BENDING TEST GIRDER
FOR
TRANSVERSE LOADING PLATFORM
OF 5,000,000 LB. TESTING MACHINE



NOTE:
Space between double stiffeners are equivalent to working spans of the 5,000,000# machine transverse loading platform. Bridging is required for intermediate span specimens.

SCALE: $\frac{3}{16}$" = 1'0"

LOCATION OF MAIN MEMBERS ON TRANSVERSE LOADING PLATFORM

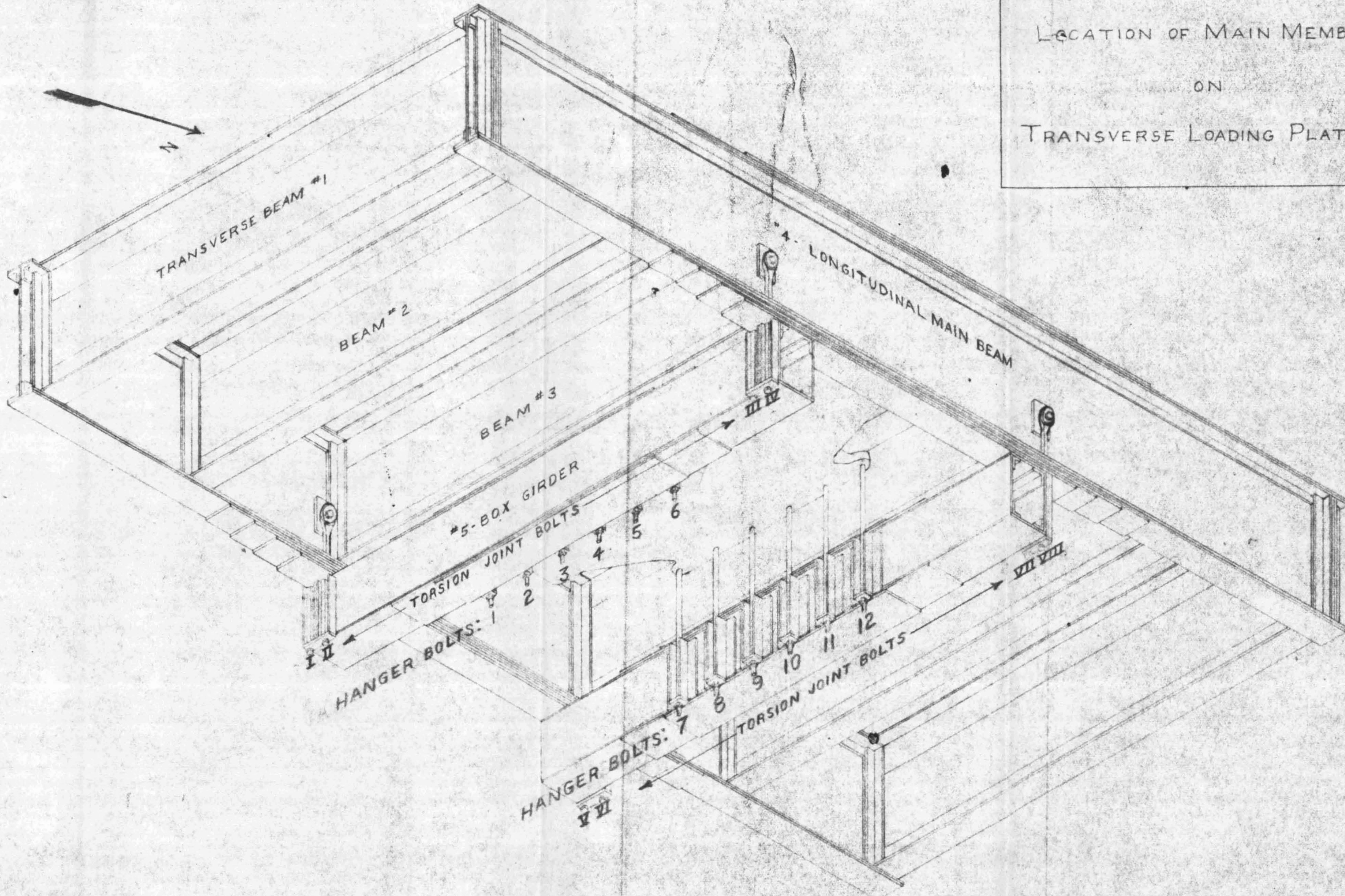


PLATE 5

DIAL GAGE LOCATIONS
ON
TRANSVERSE LOADING PLATFORM
OF
5,000,000 LB. TESTING MACHINE

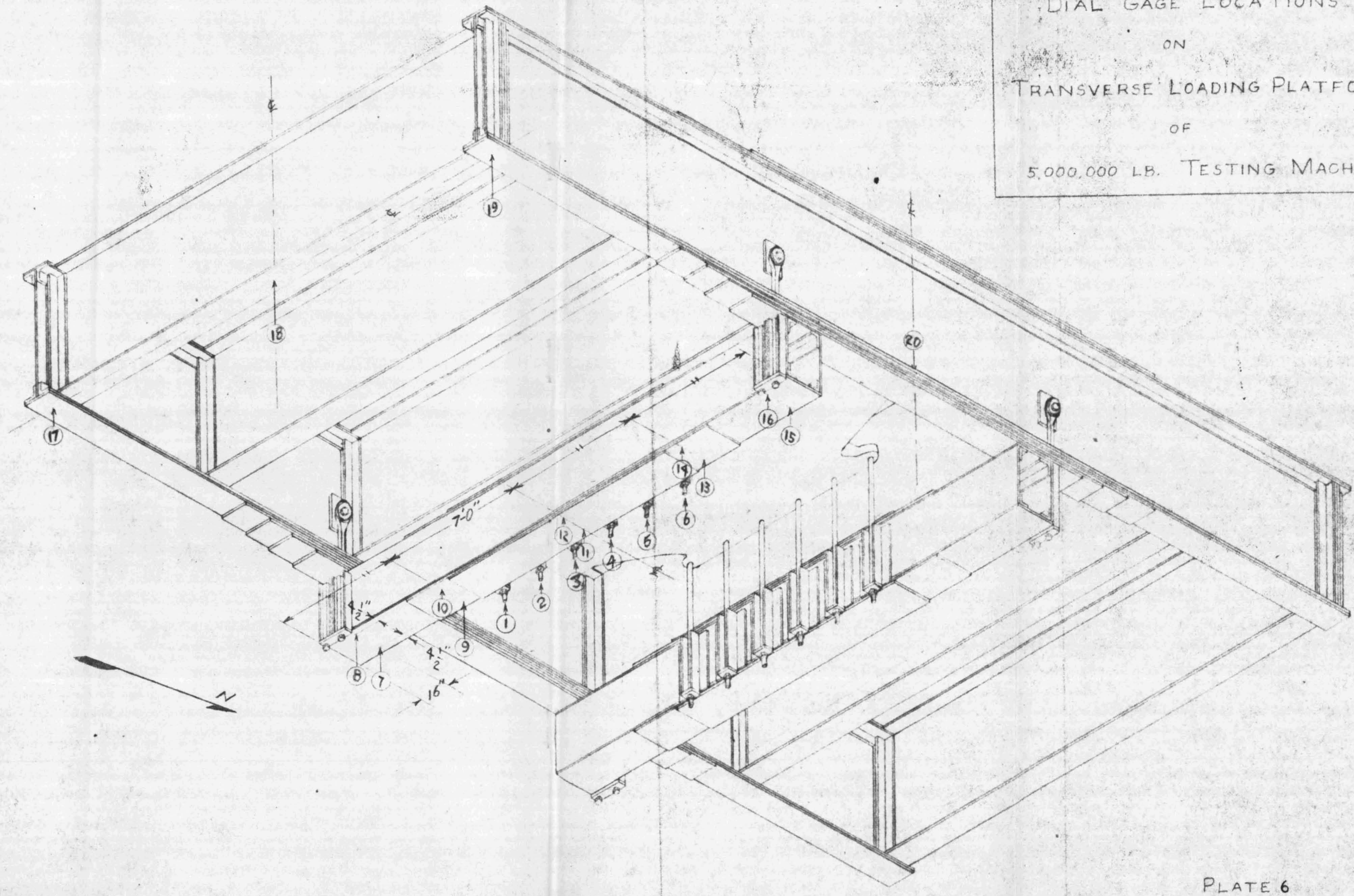
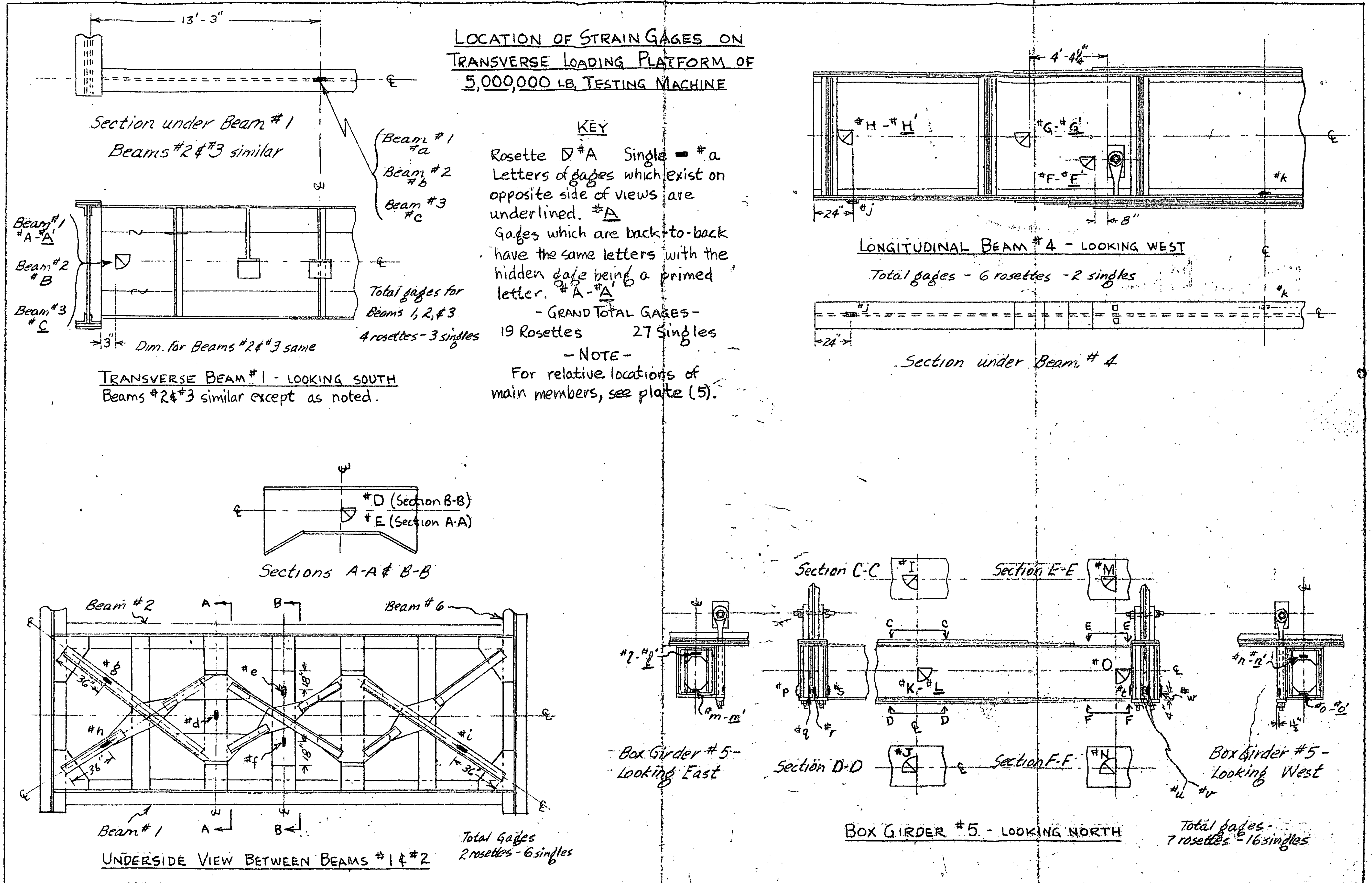
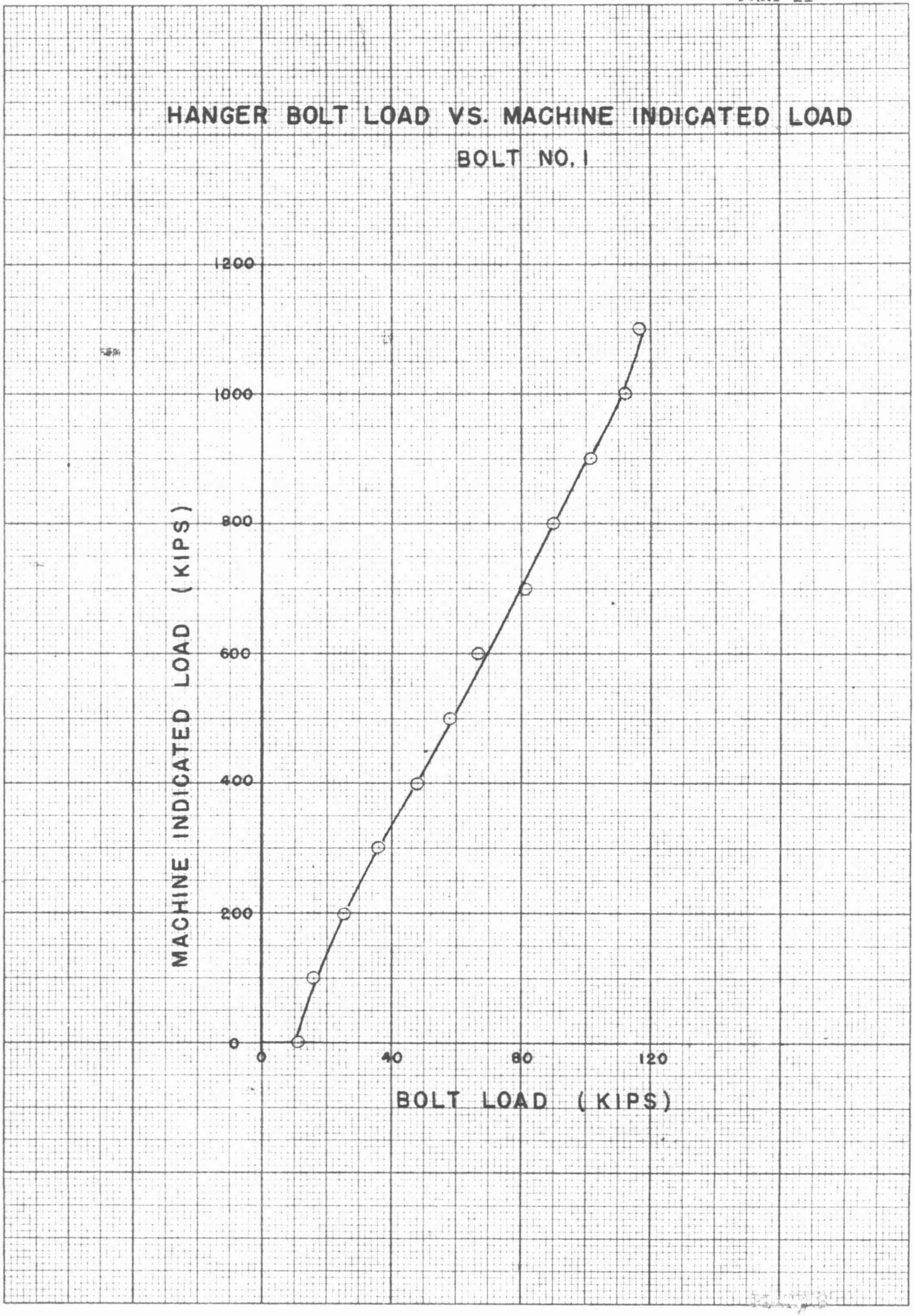
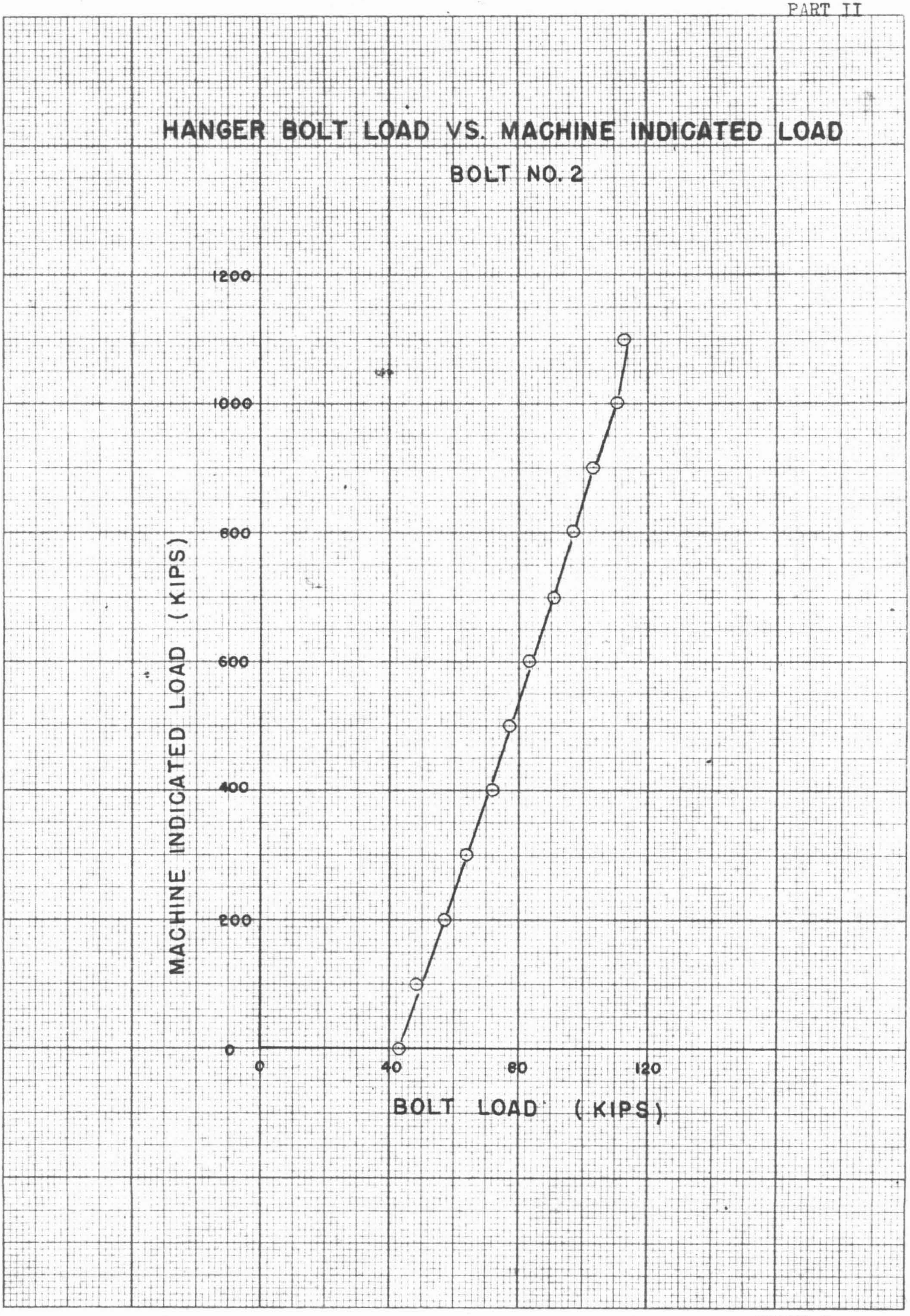
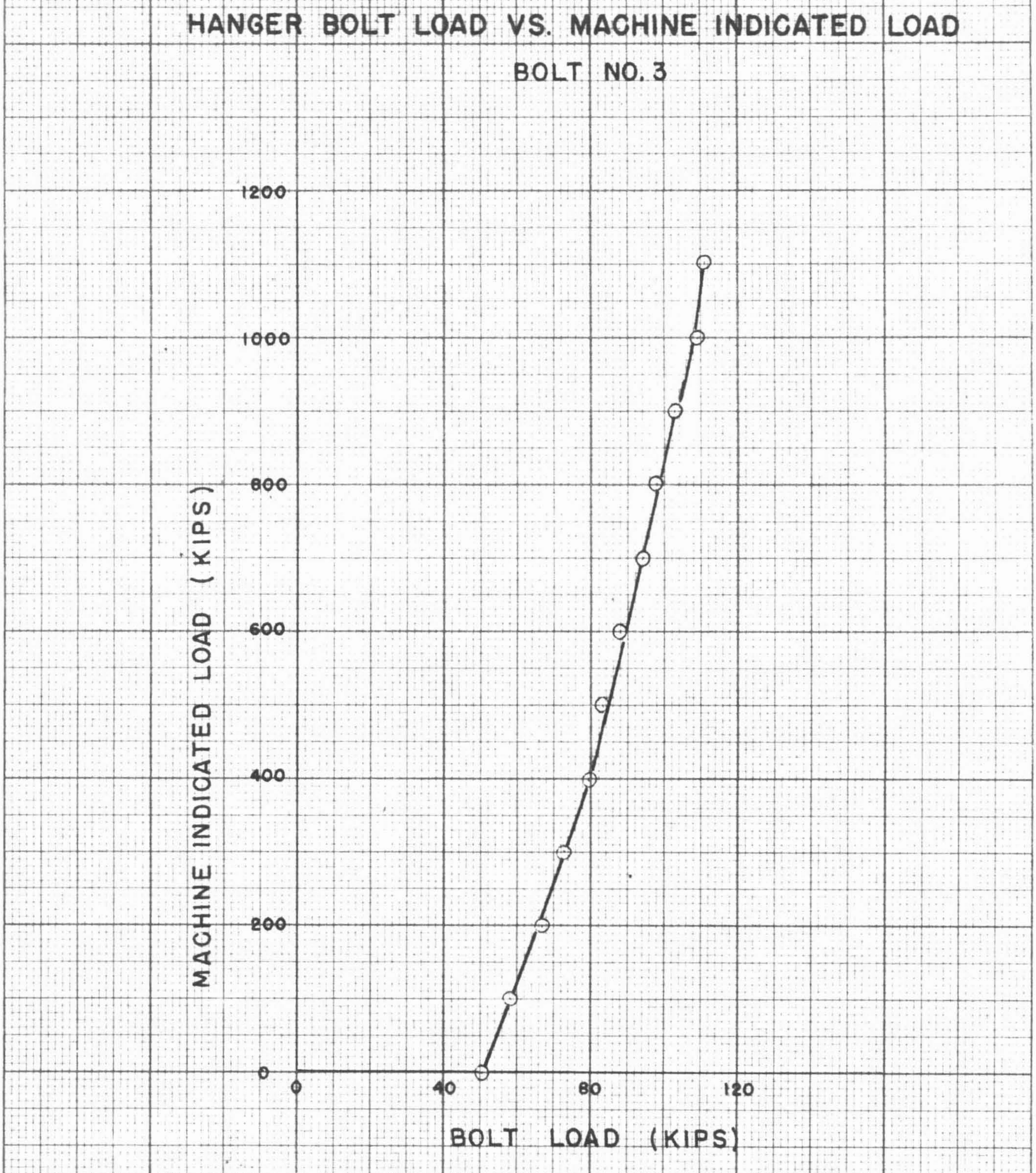


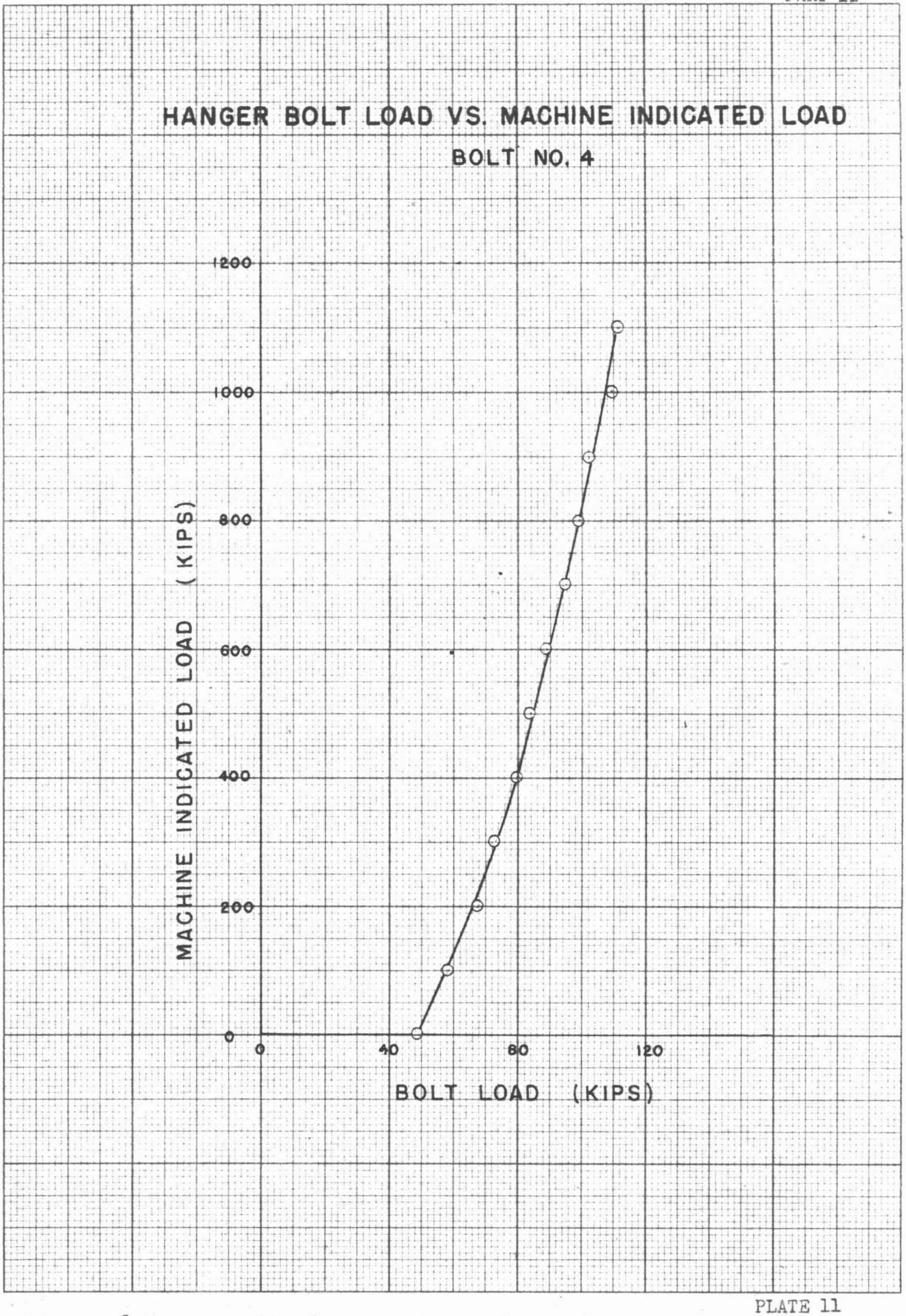
PLATE 6

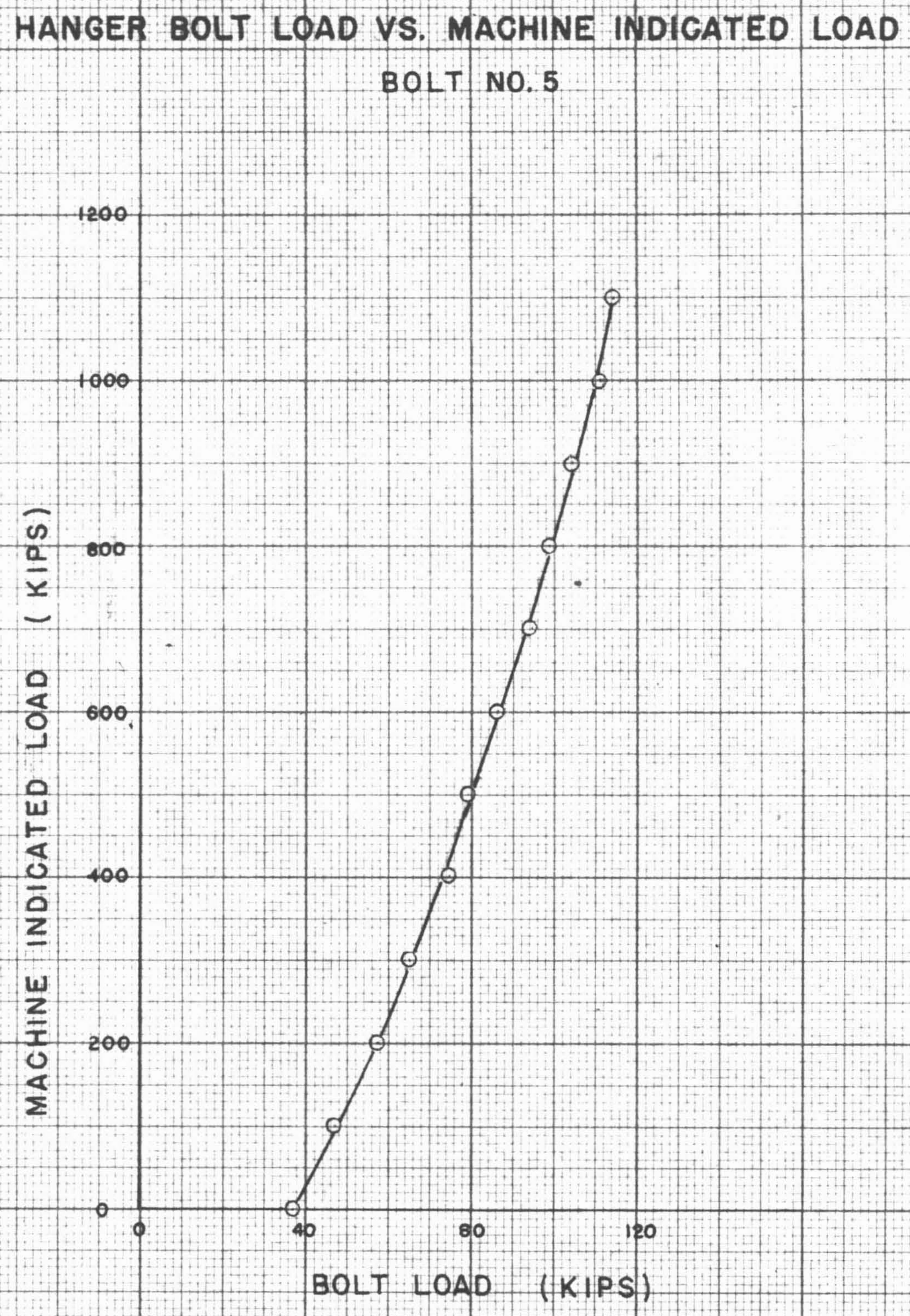

LOCATION OF STRAIN GAGES ON
TRANSVERSE LOADING PLATFORM OF
5,000,000 LB. TESTING MACHINE
KEY
Rosette #A Single #a
Letters of gages which exist on opposite side of views are underlined. #A
Gages which are back-to-back have the same letters with the hidden gage being a primed letter. #A-#A'
- GRAND TOTAL GAGES -
19 Rosettes 27 Singles
- NOTE -
For relative locations of main members, see plate (5).
13'-3"
Section under Beam #1
Beams #2 & #3 similar
Beam #1 #a
Beam #2 #b
Beam #3 #c
Beam #1 #A-#A'
Beam #2 #B
Beam #3 #C
Total gages for Beams 1, 2, & 3
4 rosettes - 3 singles
3"
Dim. for Beams #2 & #3 same
TRANSVERSE BEAM #1 - LOOKING SOUTH
Beams #2 & #3 similar except as noted.
4'-4¼"
#H-#H'
#G-#G'
#F-#F'
#k
24"
#j
8"
LONGITUDINAL BEAM #4 - LOOKING WEST
Total gages - 6 rosettes - 2 singles
Section under Beam #4
#D (Section B-B)
#E (Section A-A)
Sections A-A & B-B
Beam #2
Beam #6
Beam #1
#g
#e
#d
#h
#f
#i
36"
18"
Total Gages
2 rosettes - 6 singles
UNDERSIDE VIEW BETWEEN BEAMS #1 & #2
Section C-C
#I
Section E-E
#M
#l-#l'
#m-#m'
#p
#s
#q
#r
#K-#L
#O
#t
#w
#n-#n'
#o-#o'
#u
#v
Box Girder #5 - Looking East
Section D-D
#J
Section F-F
#N
Box Girder #5 - Looking West
BOX GIRDER #5 - LOOKING NORTH
Total gages - 7 rosettes - 16 singles

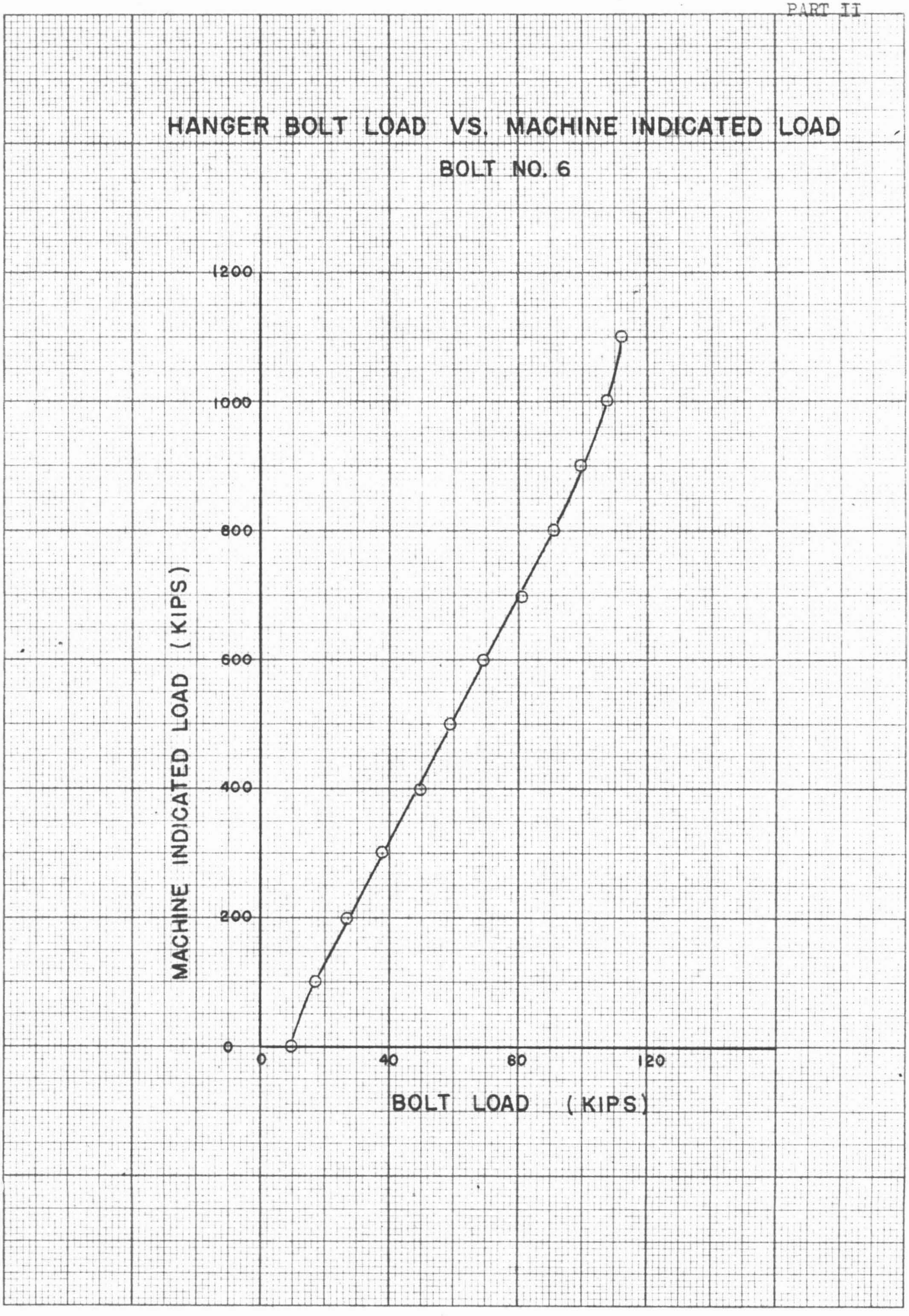

HANGER BOLT LOAD VS. MACHINE INDICATED LOAD
BOLT NO. 1
MACHINE INDICATED LOAD (KIPS)
1200
1000
800
600
400
200
0
0
40
80
120
BOLT LOAD (KIPS)

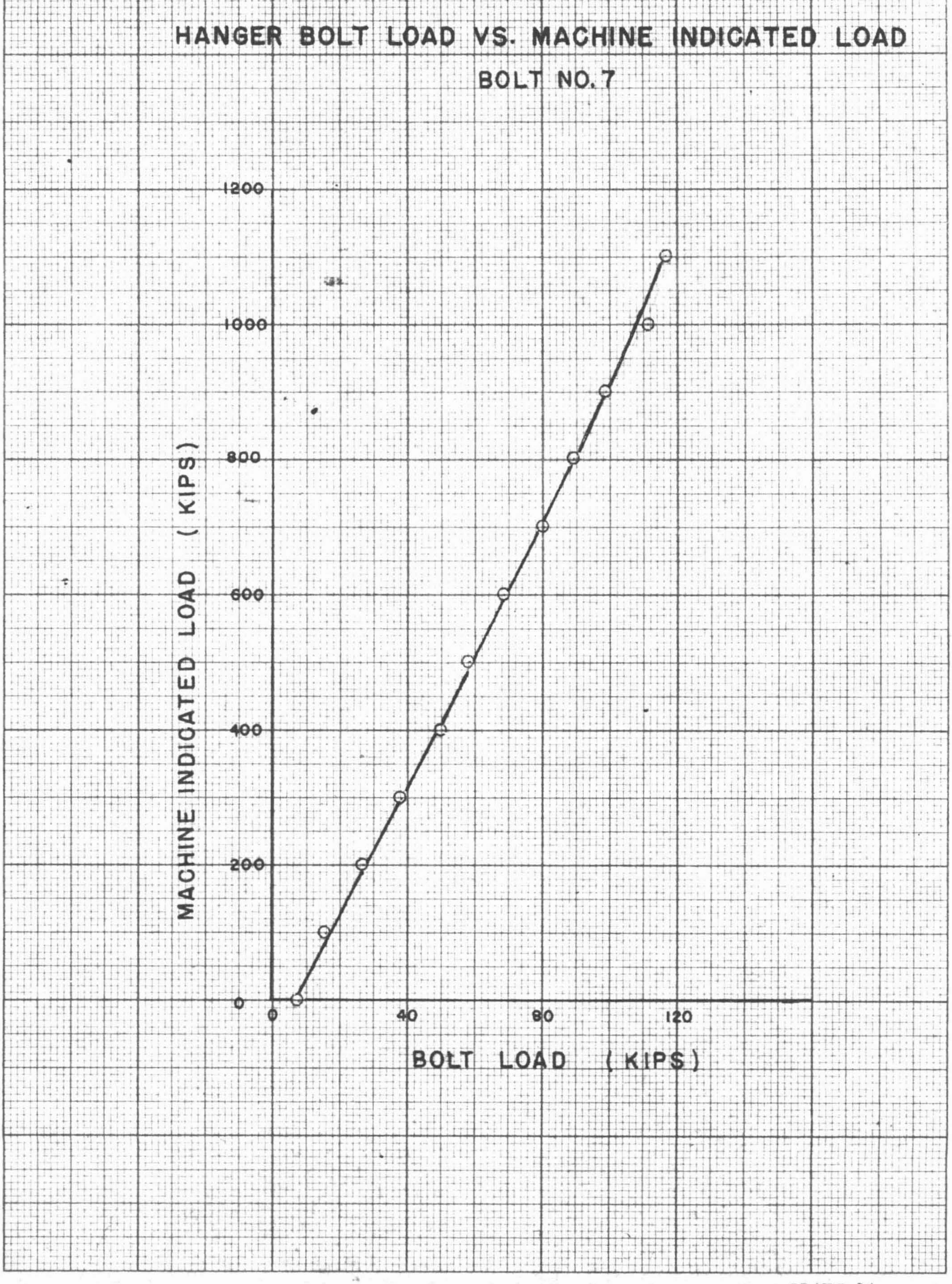

HANGER BOLT LOAD VS. MACHINE INDICATED LOAD
BOLT NO. 2
MACHINE INDICATED LOAD (KIPS)
1200
1000
800
600
400
200
0
0
40
80
120
BOLT LOAD (KIPS)


HANGER BOLT LOAD VS. MACHINE INDICATED LOAD
BOLT NO. 3
MACHINE INDICATED LOAD (KIPS)
1200
1000
800
600
400
200
0
0
40
80
120
BOLT LOAD (KIPS)


HANGER BOLT LOAD VS. MACHINE INDICATED LOAD
BOLT NO. 4
MACHINE INDICATED LOAD (KIPS)
1200
1000
800
600
400
200
0
0
40
80
120
BOLT LOAD (KIPS)

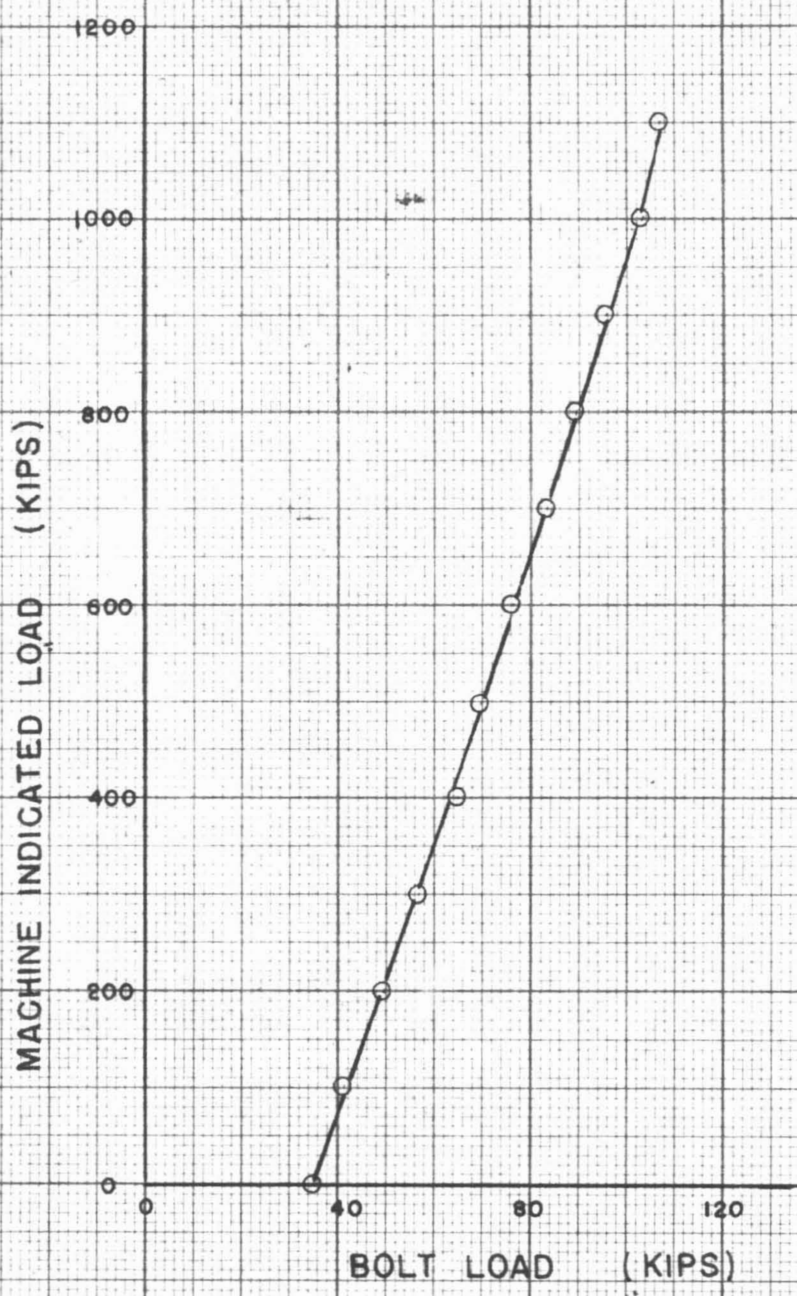

HANGER BOLT LOAD VS. MACHINE INDICATED LOAD
BOLT NO. 5
MACHINE INDICATED LOAD (KIPS)
1200
1000
800
600
400
200
0
0
40
80
120
BOLT LOAD (KIPS)

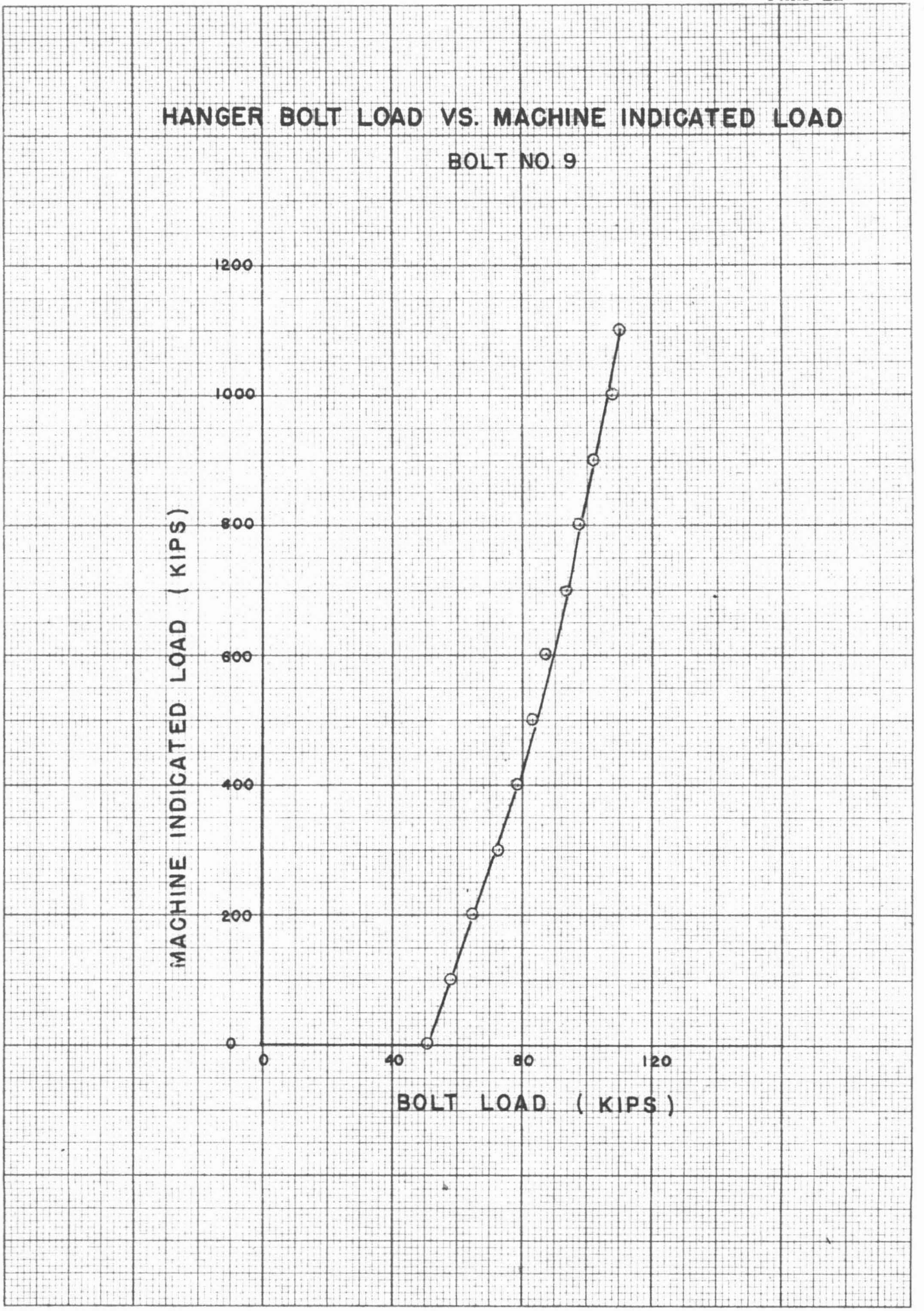

HANGER BOLT LOAD VS. MACHINE INDICATED LOAD
BOLT NO. 6
MACHINE INDICATED LOAD (KIPS)
1200
1000
800
600
400
200
0
0
40
80
120
BOLT LOAD (KIPS)

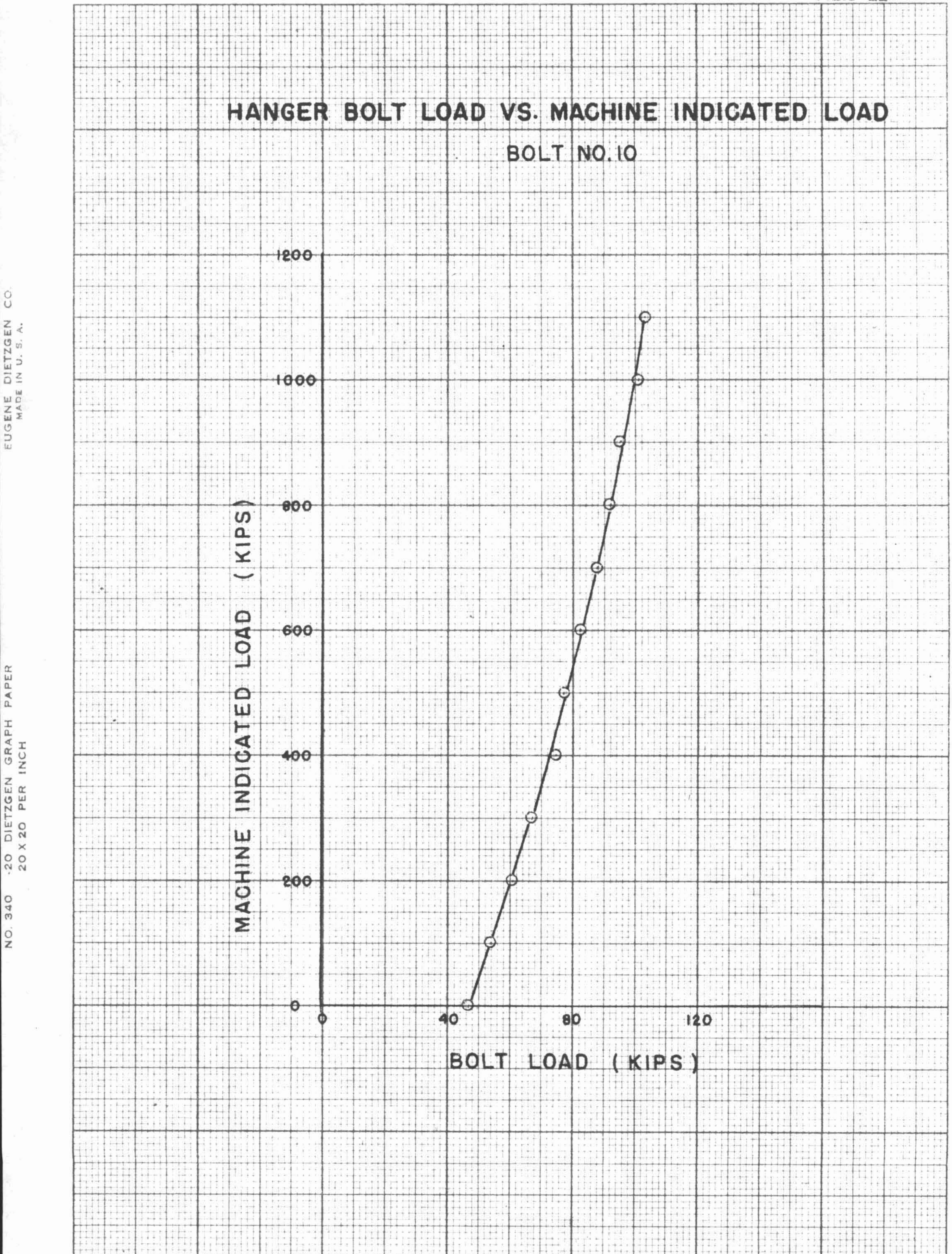

HANGER BOLT LOAD VS. MACHINE INDICATED LOAD
BOLT NO. 7
MACHINE INDICATED LOAD (KIPS)
1200
1000
800
600
400
200
0
0
40
80
120
BOLT LOAD (KIPS)

HANGER BOLT LOAD VS. MACHINE INDICATED LOAD

BOLT NO. 8




HANGER BOLT LOAD VS. MACHINE INDICATED LOAD
BOLT NO. 9
MACHINE INDICATED LOAD (KIPS)
1200
1000
800
600
400
200
0
0
40
80
120
BOLT LOAD (KIPS)


HANGER BOLT LOAD VS. MACHINE INDICATED LOAD
BOLT NO. 10
MACHINE INDICATED LOAD (KIPS)
BOLT LOAD (KIPS)
1200
1000
800
600
400
200
0
0
40
80
120
NO. 340 -20 DIETZGEN GRAPH PAPER
20 X 20 PER INCH
EUGENE DIETZGEN CO.
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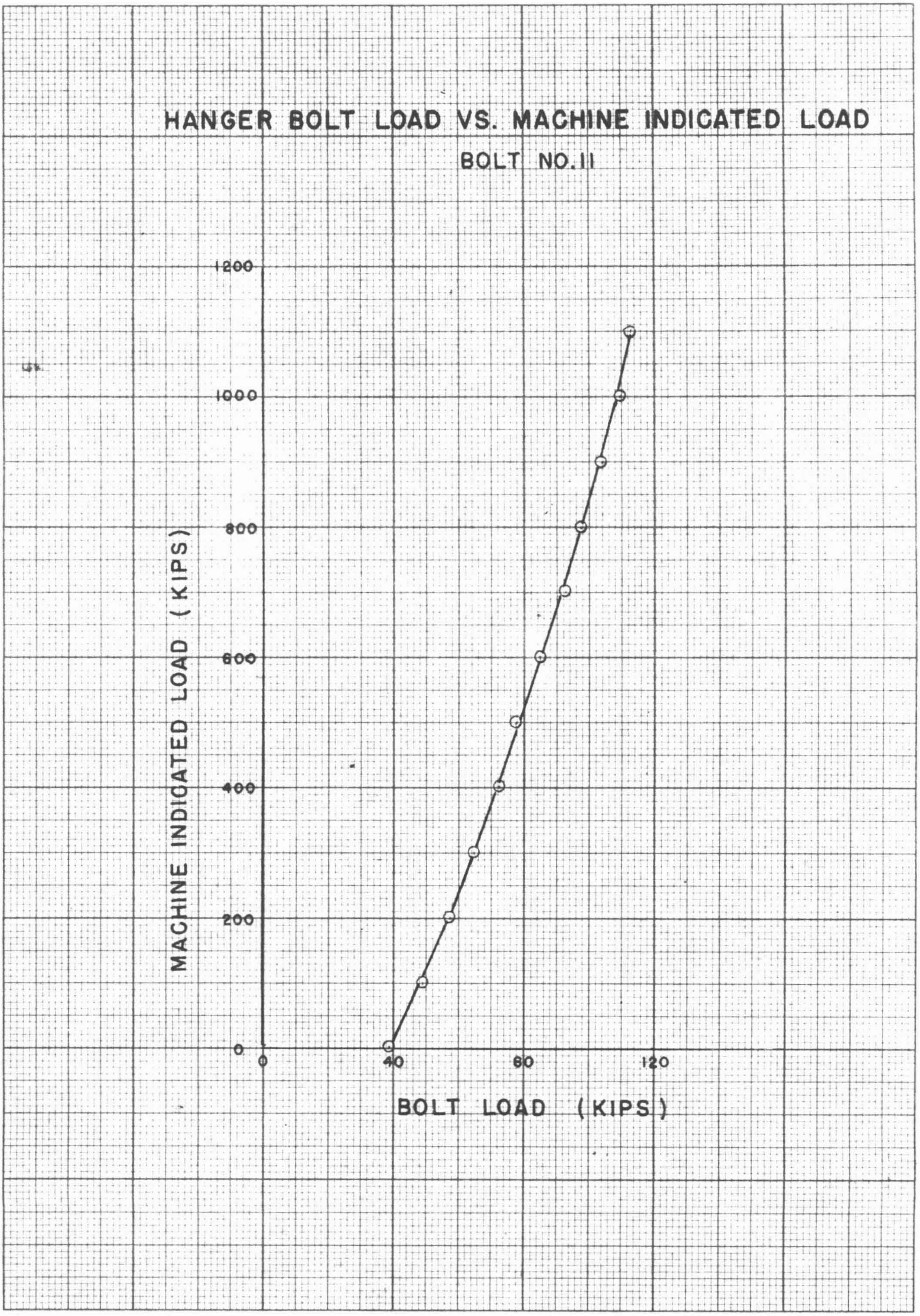
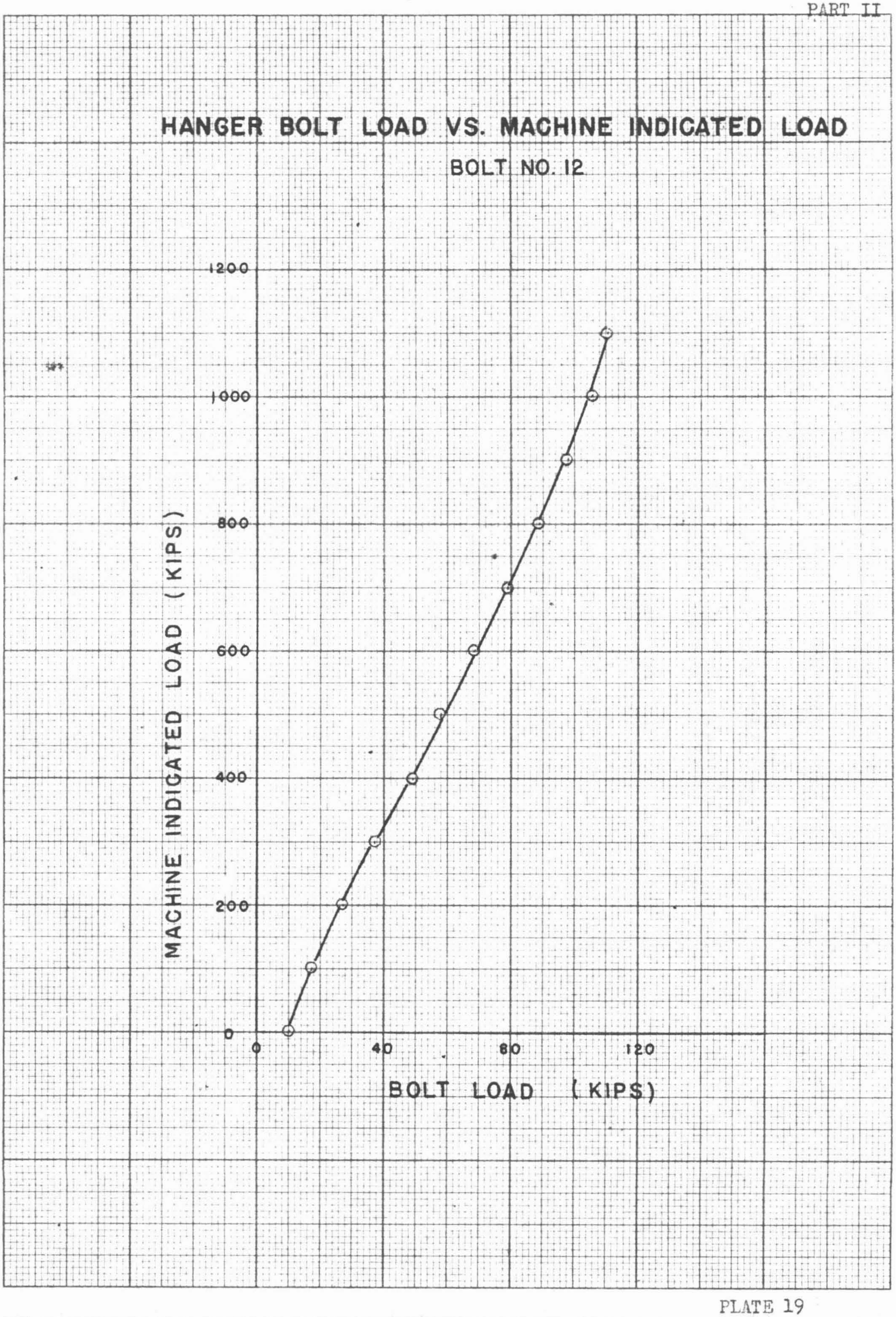
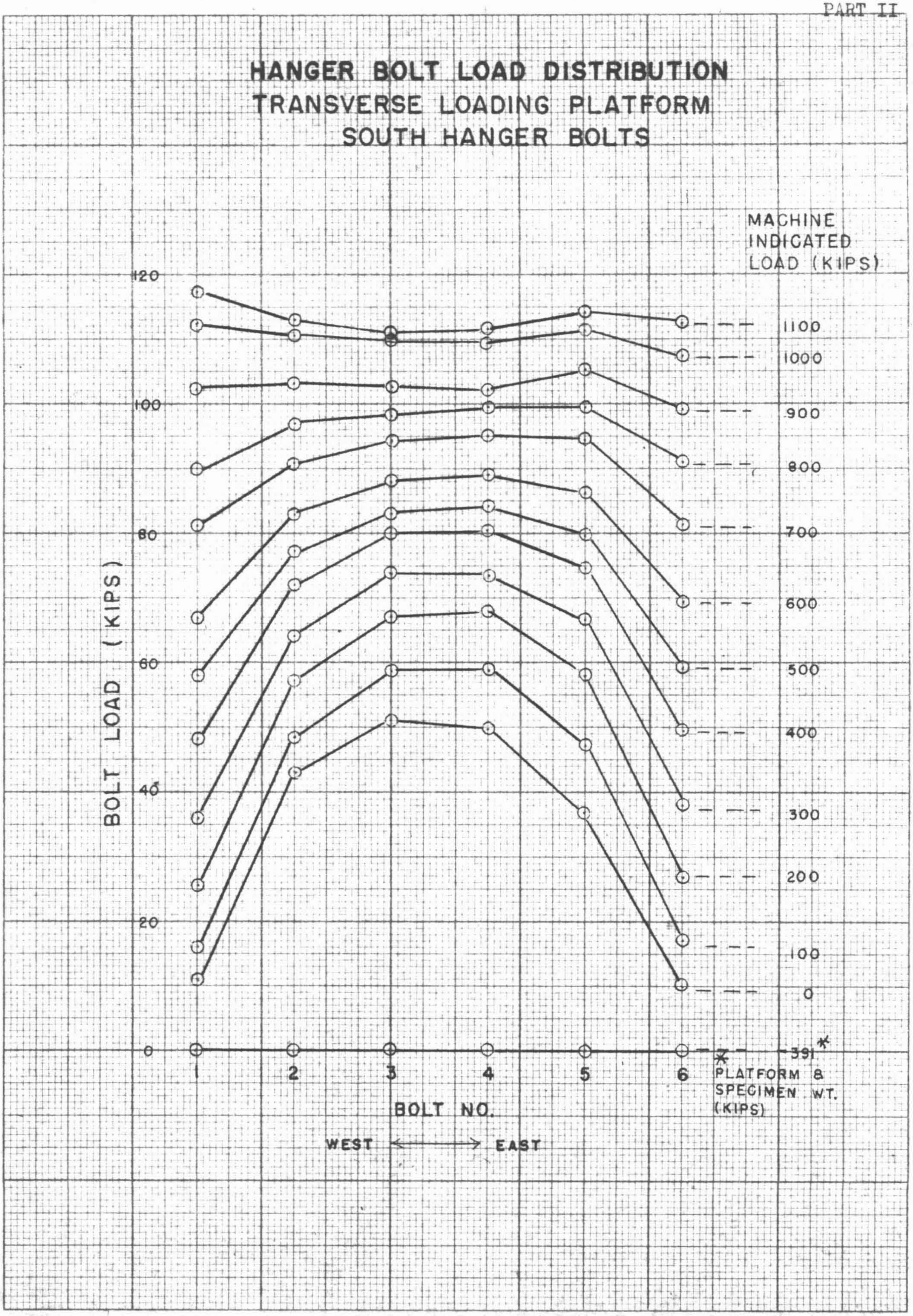
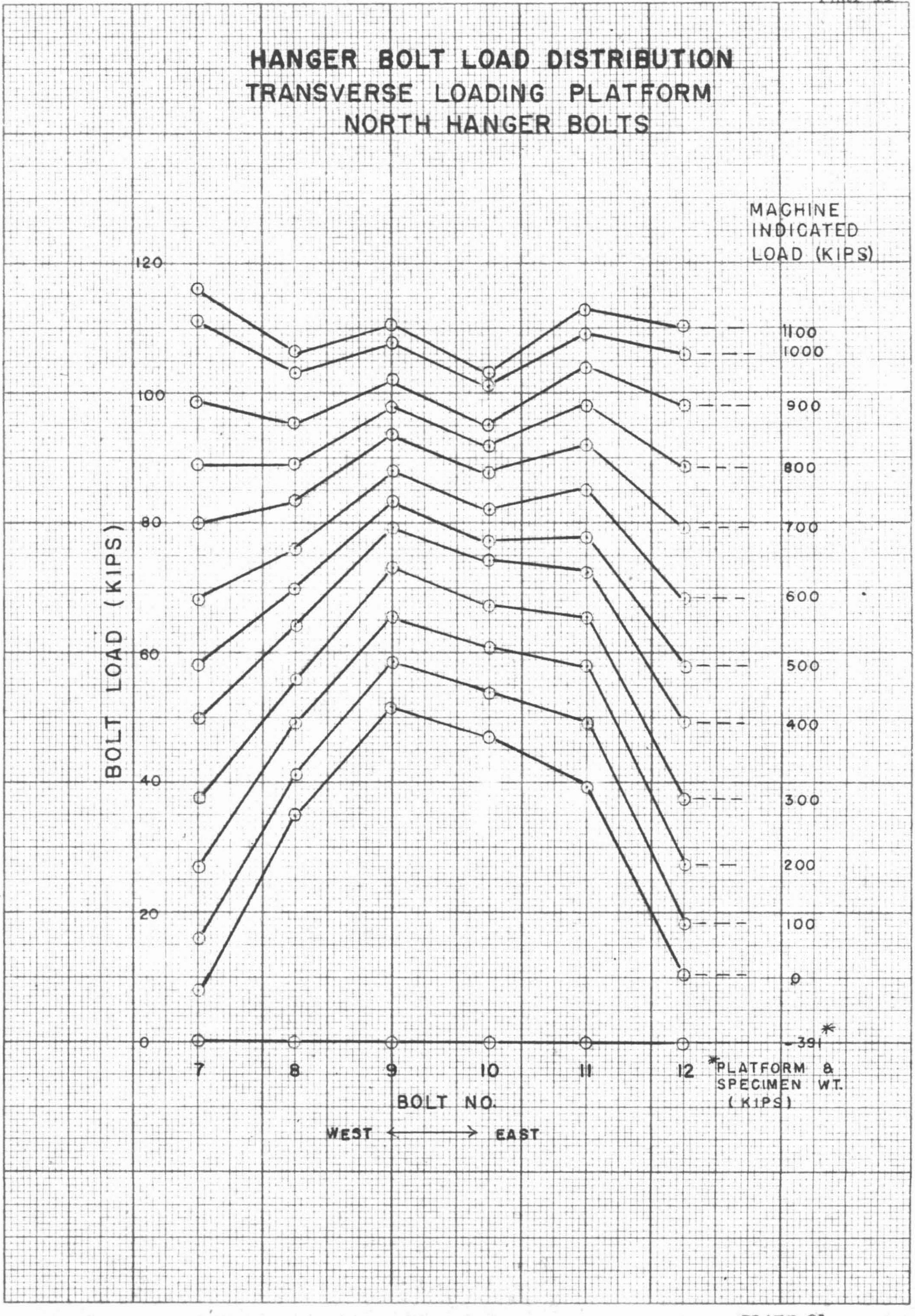
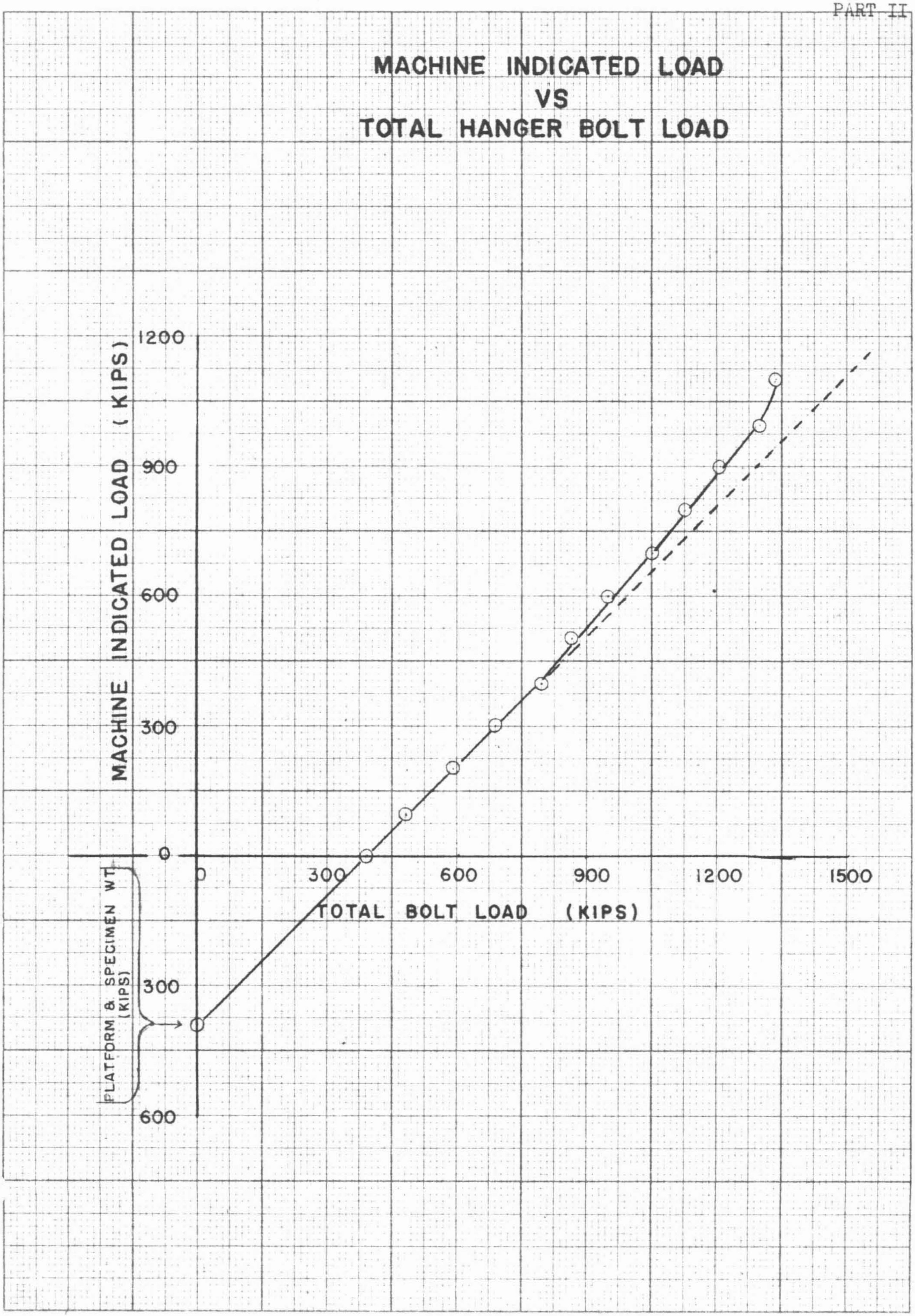
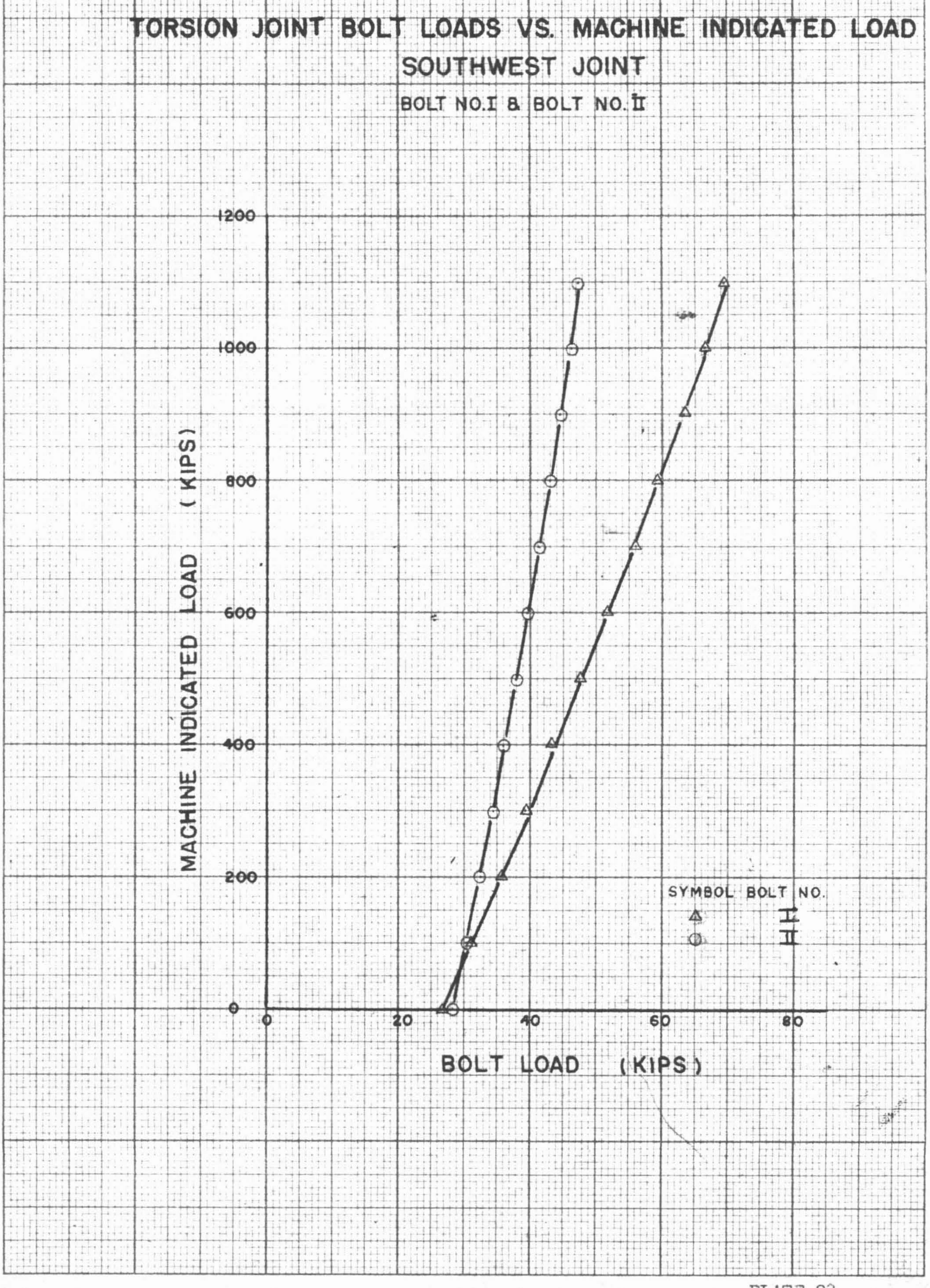

HANGER BOLT LOAD VS. MACHINE INDICATED LOAD
BOLT NO. 11
MACHINE INDICATED LOAD (KIPS)
1200
1000
800
600
400
200
0
0
40
80
120
BOLT LOAD (KIPS)

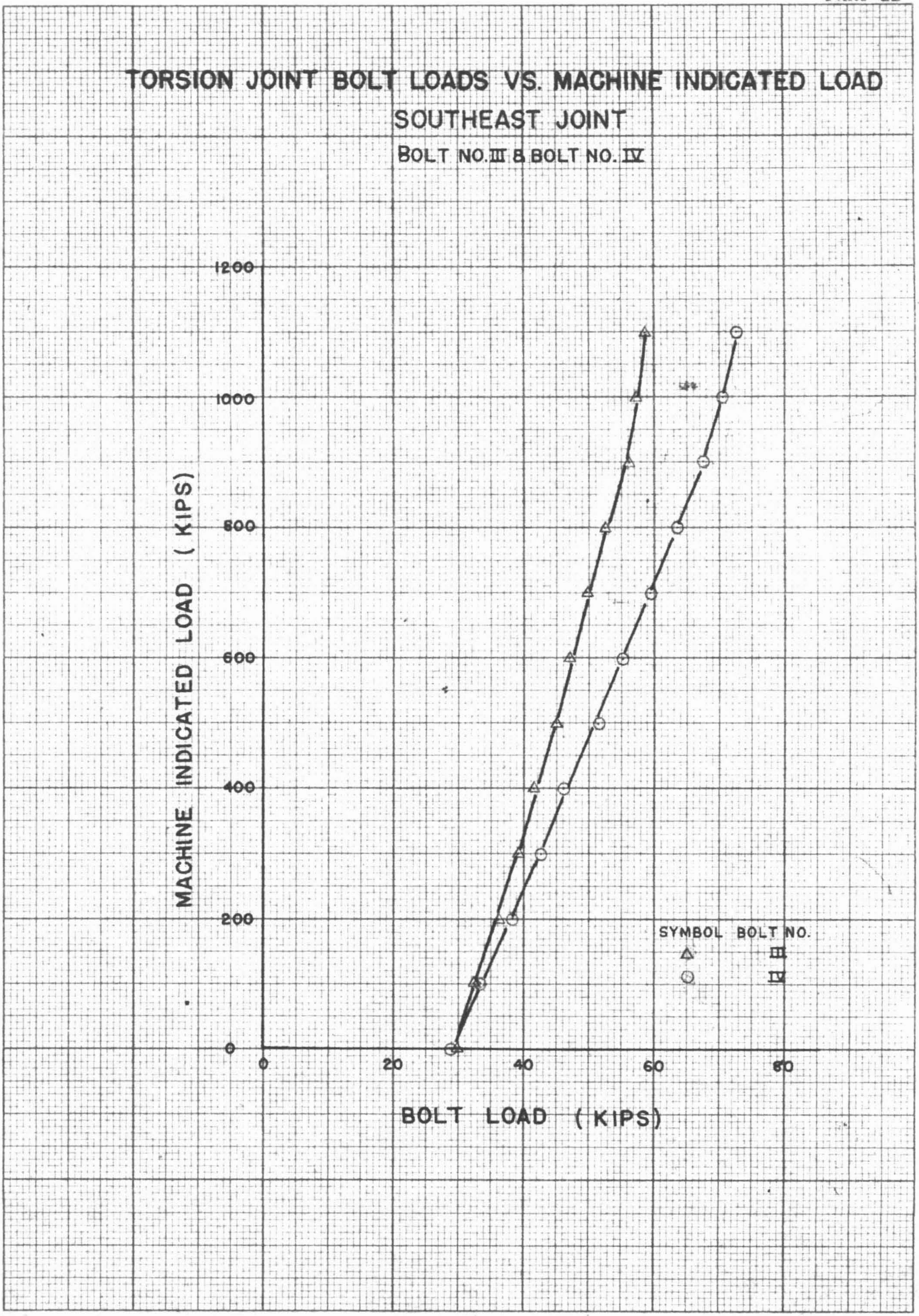

HANGER BOLT LOAD VS. MACHINE INDICATED LOAD
BOLT NO. 12
MACHINE INDICATED LOAD (KIPS)
BOLT LOAD (KIPS)
1200
1000
800
600
400
200
0
0
40
80
120

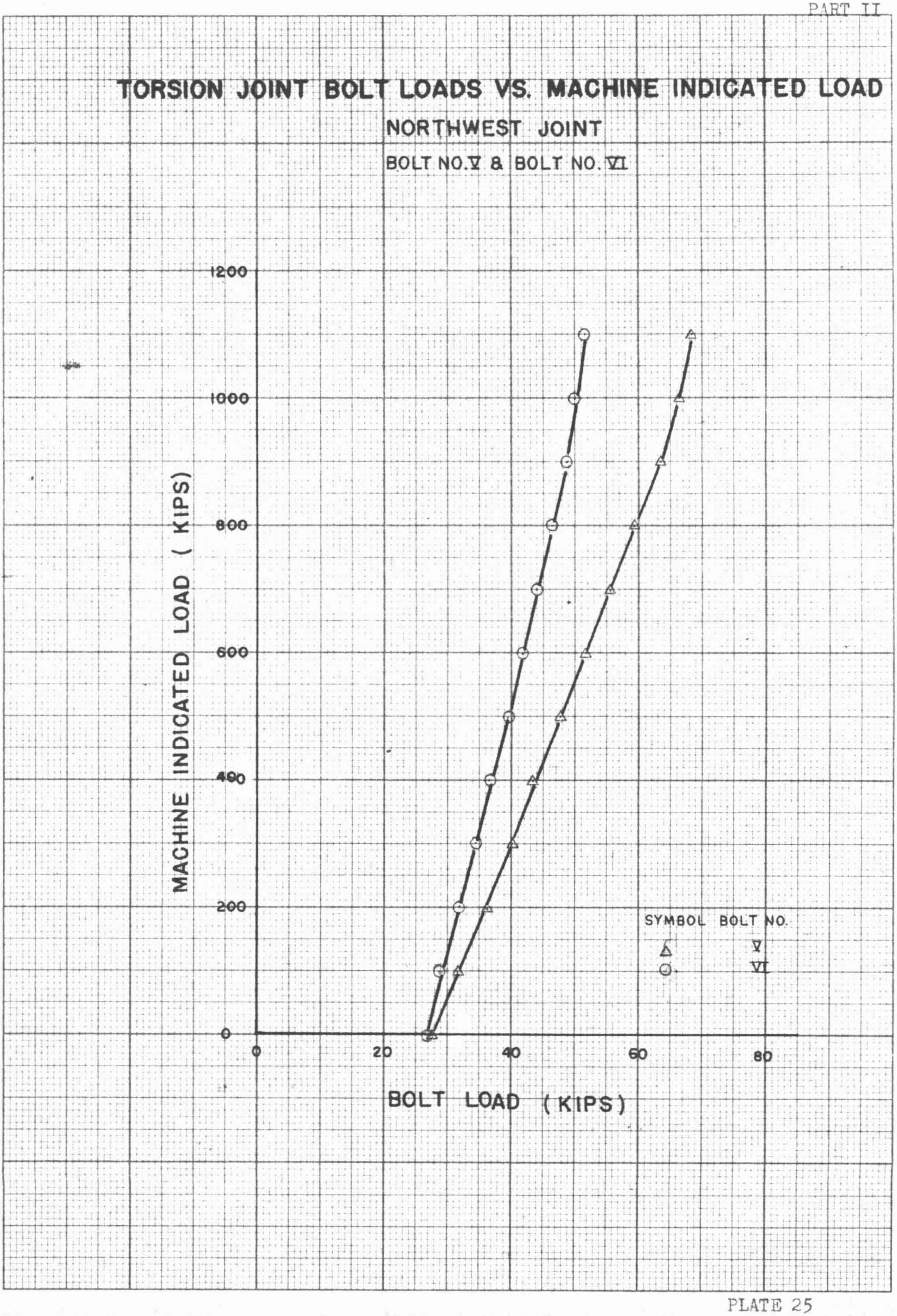

HANGER BOLT LOAD DISTRIBUTION
TRANSVERSE LOADING PLATFORM
SOUTH HANGER BOLTS
MACHINE INDICATED LOAD (KIPS)
BOLT LOAD (KIPS)
120
100
80
60
40
20
0
1100
1000
900
800
700
600
500
400
300
200
100
0
-391*
1
2
3
4
5
6
*PLATFORM & SPECIMEN WT. (KIPS)
BOLT NO.
WEST ⟷ EAST

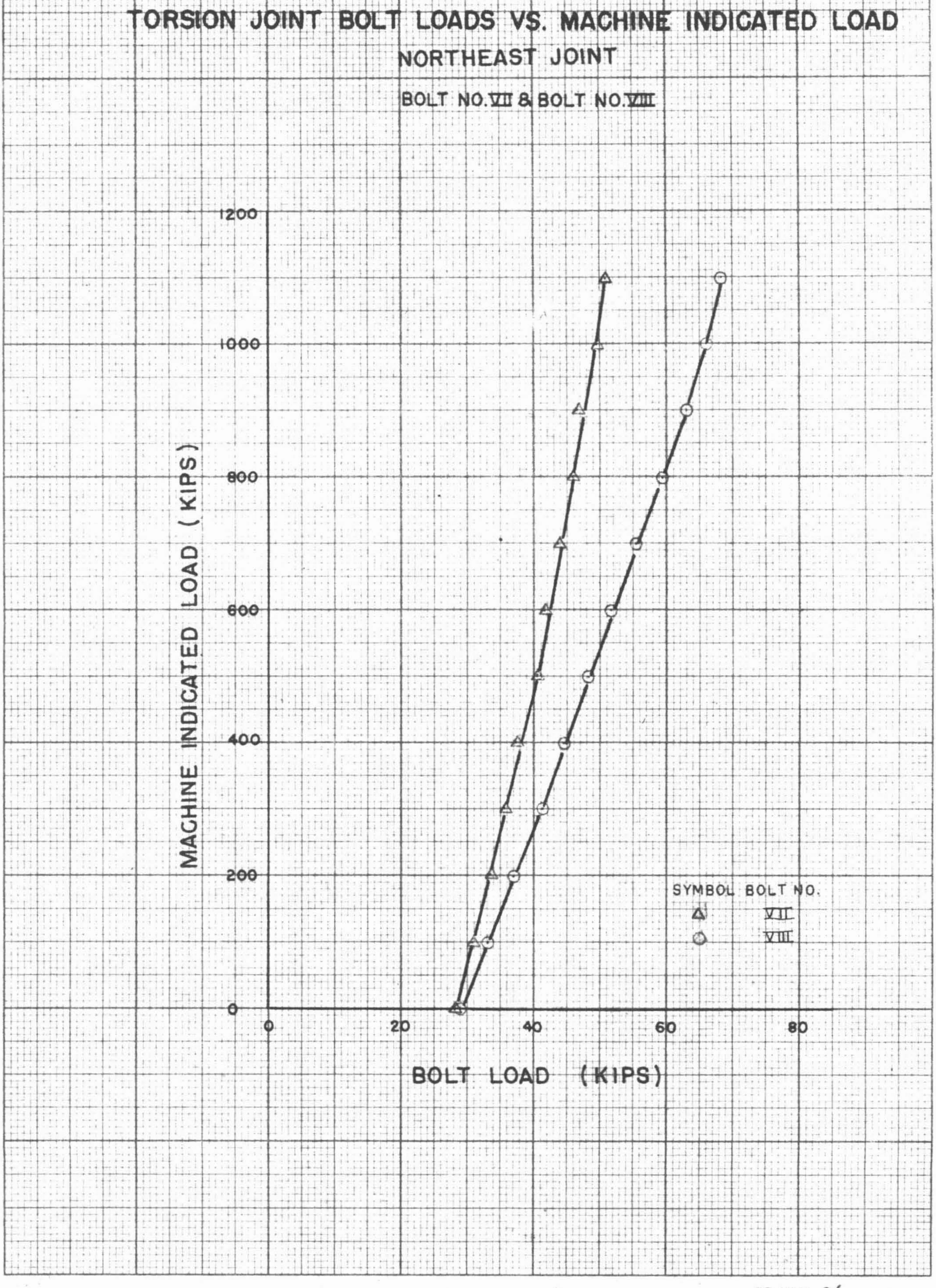

HANGER BOLT LOAD DISTRIBUTION
TRANSVERSE LOADING PLATFORM
NORTH HANGER BOLTS
MACHINE INDICATED LOAD (KIPS)
BOLT LOAD (KIPS)
120
100
80
60
40
20
0
1100
1000
900
800
700
600
500
400
300
200
100
0
-391*
7
8
9
10
11
12
*PLATFORM & SPECIMEN WT. (KIPS)
BOLT NO.
WEST
EAST

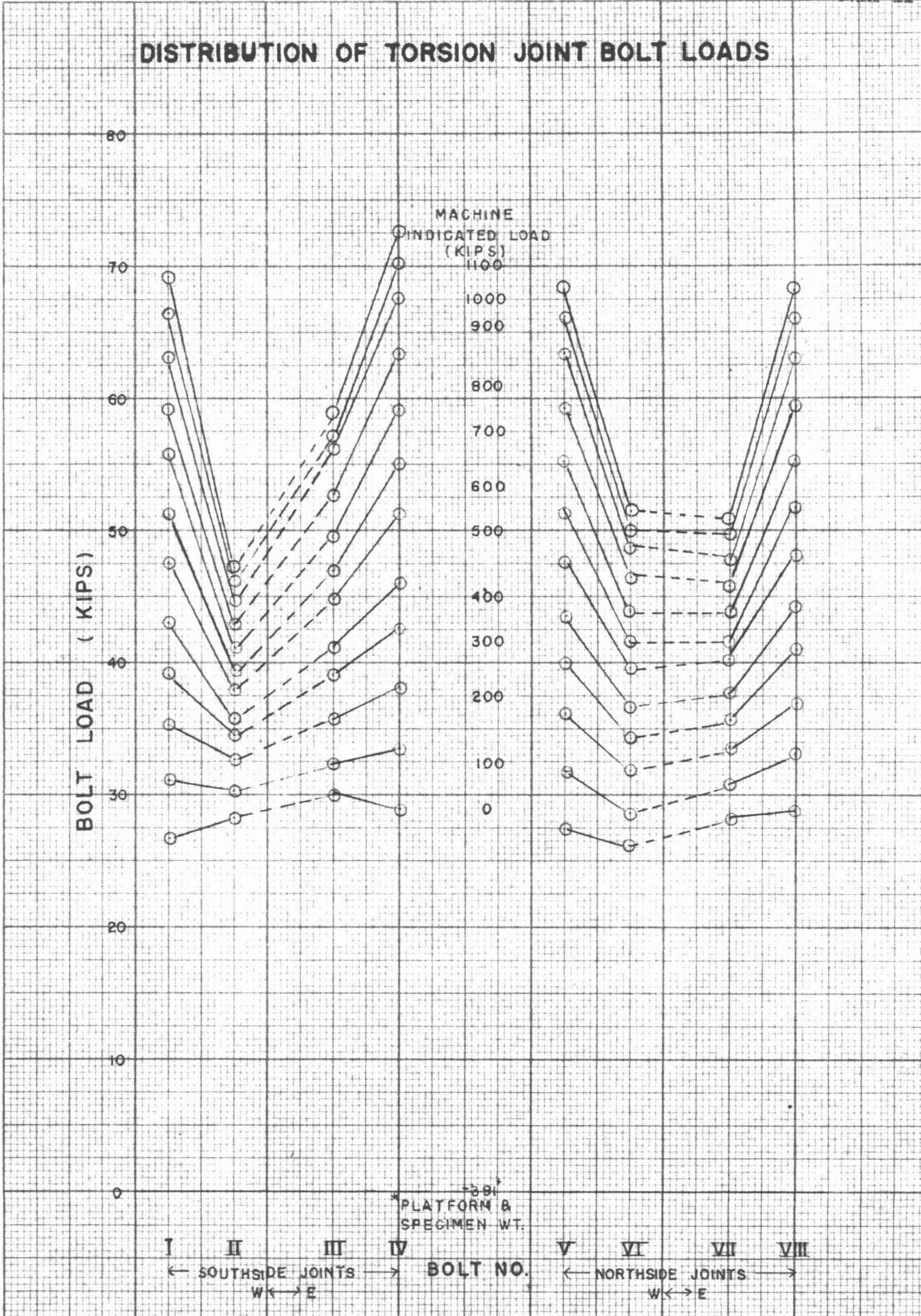

MACHINE INDICATED LOAD
VS
TOTAL HANGER BOLT LOAD
MACHINE INDICATED LOAD (KIPS)
1200
900
600
300
0
300
600
0
300
600
900
1200
1500
TOTAL BOLT LOAD (KIPS)
PLATFORM & SPECIMEN WT. (KIPS)

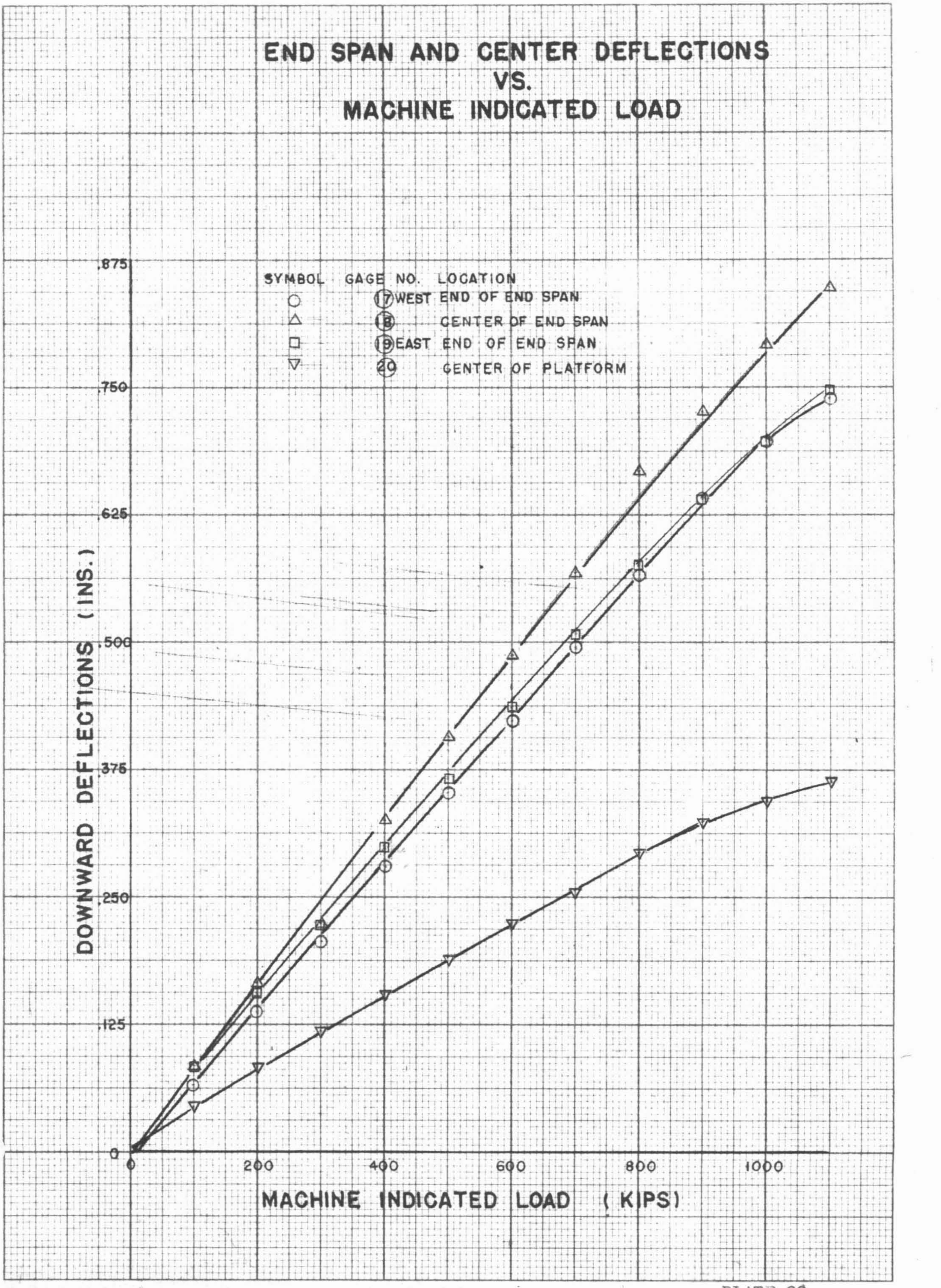

TORSION JOINT BOLT LOADS VS. MACHINE INDICATED LOAD
SOUTHWEST JOINT
BOLT NO.I & BOLT NO.II
MACHINE INDICATED LOAD (KIPS)
1200
1000
800
600
400
200
0
0
20
40
60
80
BOLT LOAD (KIPS)
SYMBOL BOLT NO.
I
II

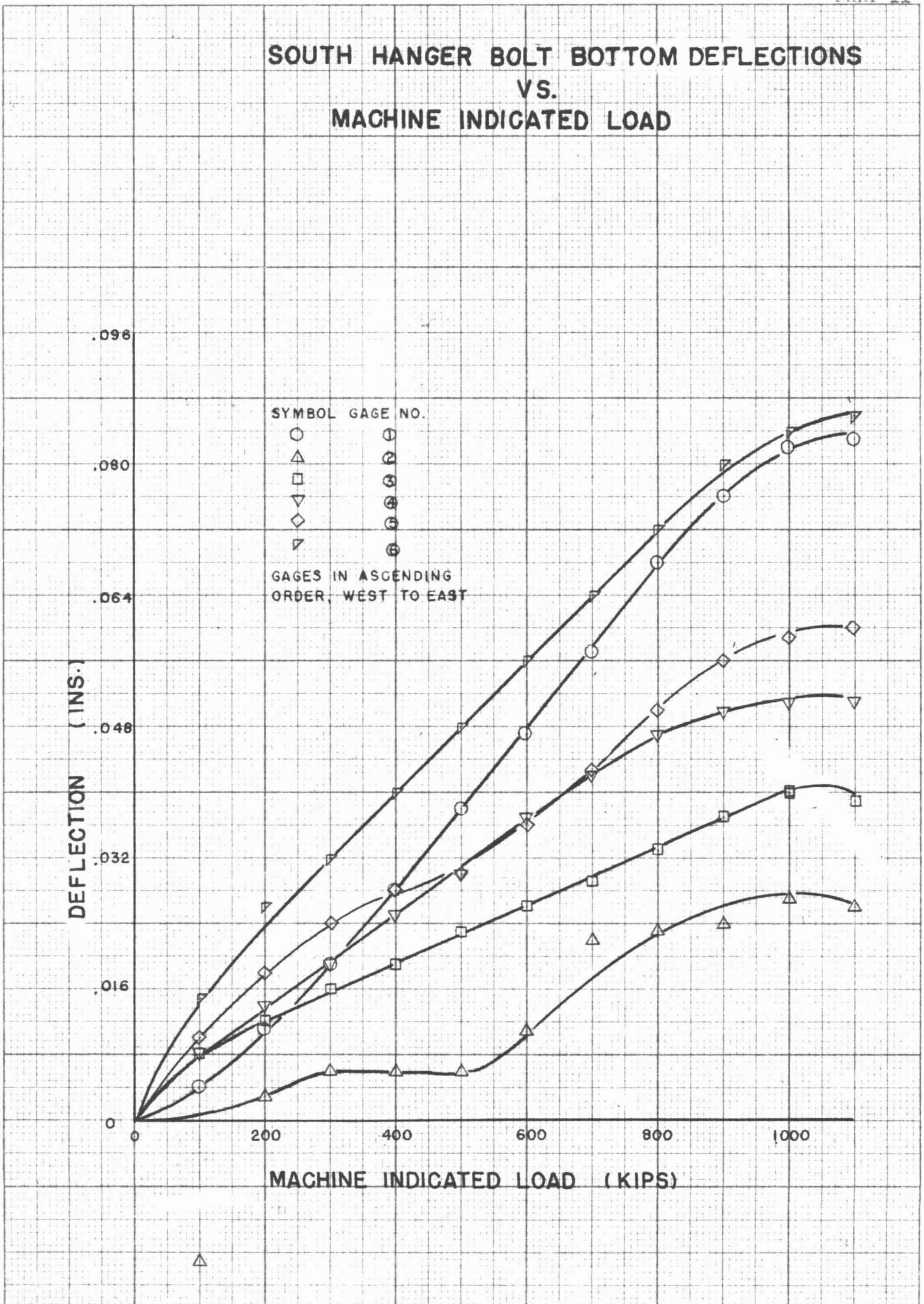

TORSION JOINT BOLT LOADS VS. MACHINE INDICATED LOAD
SOUTHEAST JOINT
BOLT NO. III & BOLT NO. IV
MACHINE INDICATED LOAD (KIPS)
1200
1000
800
600
400
200
0
0
20
40
60
80
BOLT LOAD (KIPS)
SYMBOL BOLT NO.
III
IV

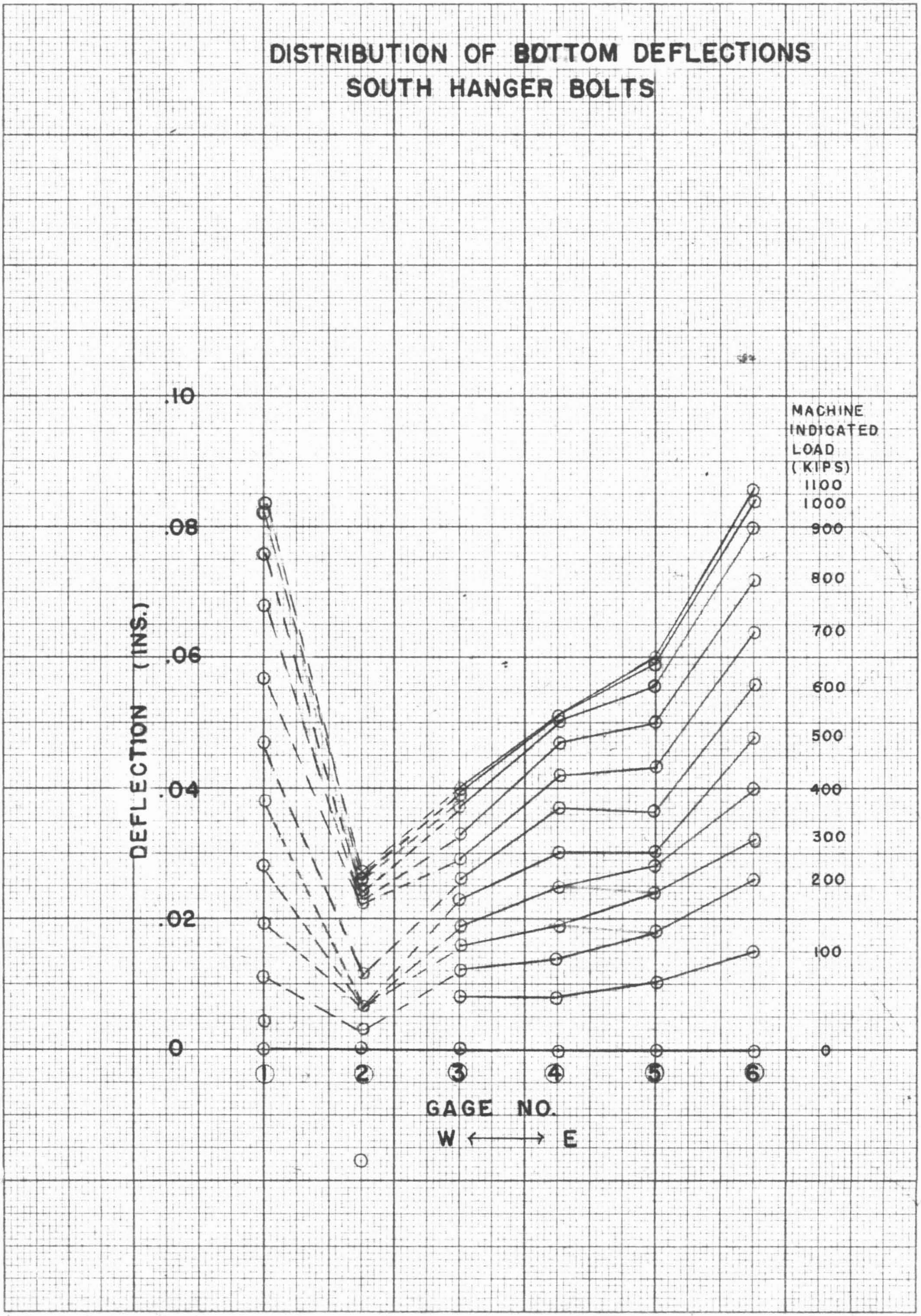

TORSION JOINT BOLT LOADS VS. MACHINE INDICATED LOAD
NORTHWEST JOINT
BOLT NO. V & BOLT NO. VI
MACHINE INDICATED LOAD (KIPS)
1200
1000
800
600
400
200
0
0
20
40
60
80
BOLT LOAD (KIPS)
SYMBOL BOLT NO.
Δ V
⊙ VI

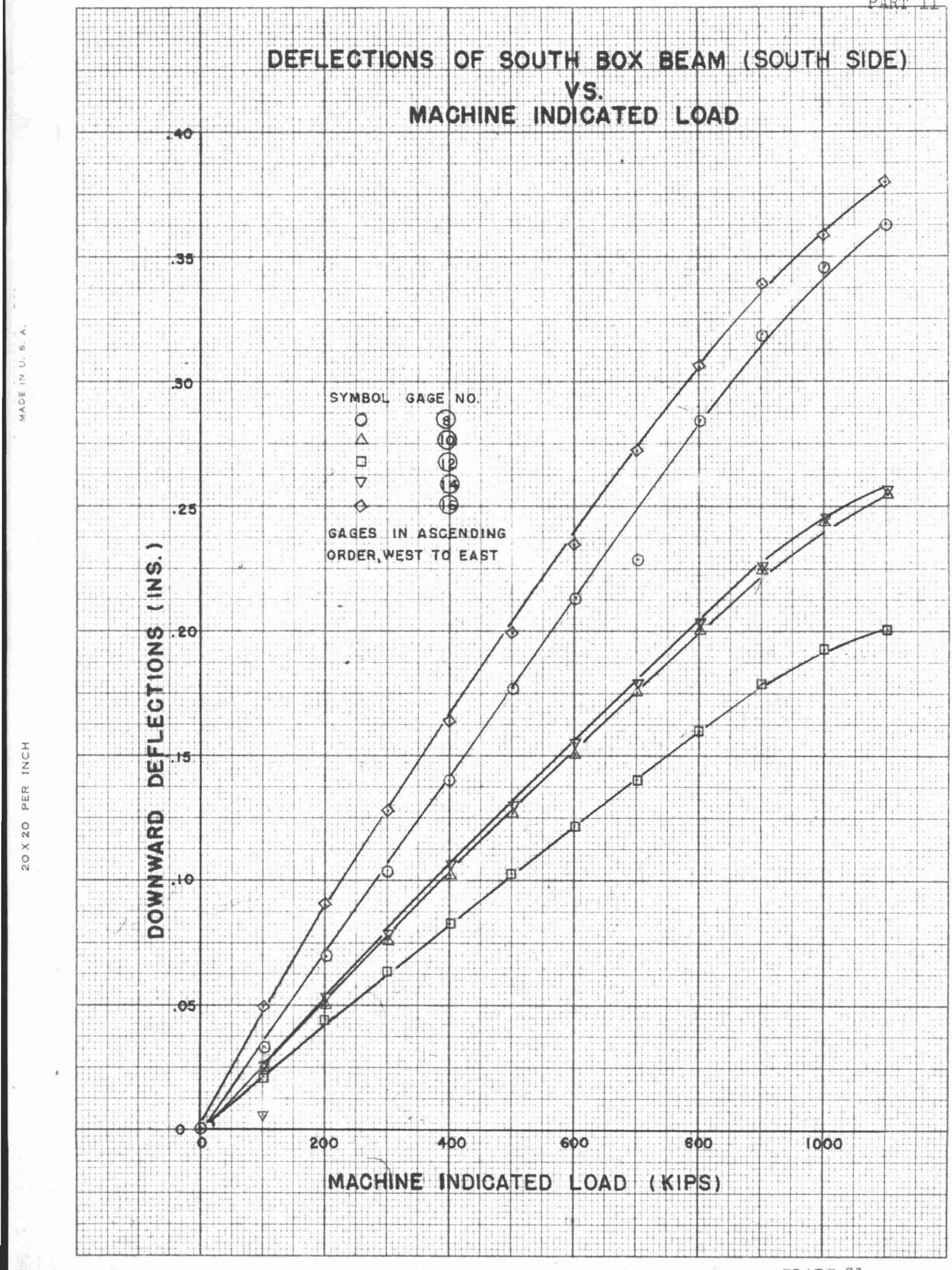

TORSION JOINT BOLT LOADS VS. MACHINE INDICATED LOAD
NORTHEAST JOINT
BOLT NO. VII & BOLT NO. VIII
MACHINE INDICATED LOAD (KIPS)
1200
1000
800
600
400
200
0
0
20
40
60
80
BOLT LOAD (KIPS)
SYMBOL BOLT NO.
VII
VIII

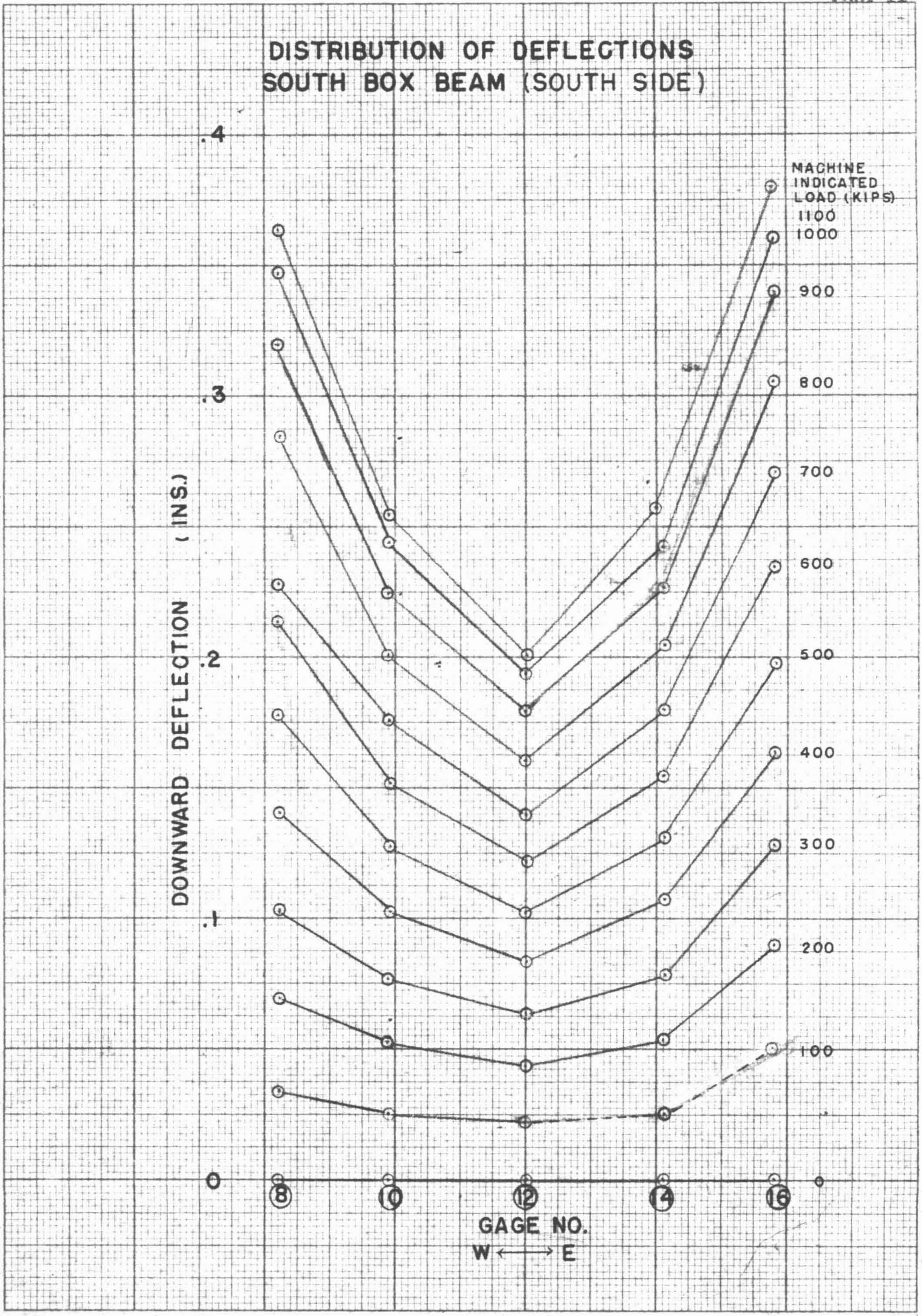

DISTRIBUTION OF TORSION JOINT BOLT LOADS
BOLT LOAD (KIPS)
80
70
60
50
40
30
20
10
0
MACHINE
INDICATED LOAD
(KIPS)
1100
1000
900
800
700
600
500
400
300
200
100
0
-391*
*PLATFORM &
SPECIMEN WT.
I
II
III
IV
V
VI
VII
VIII
BOLT NO.
← SOUTHSIDE JOINTS →
W ← → E
← NORTHSIDE JOINTS →
W ← → E

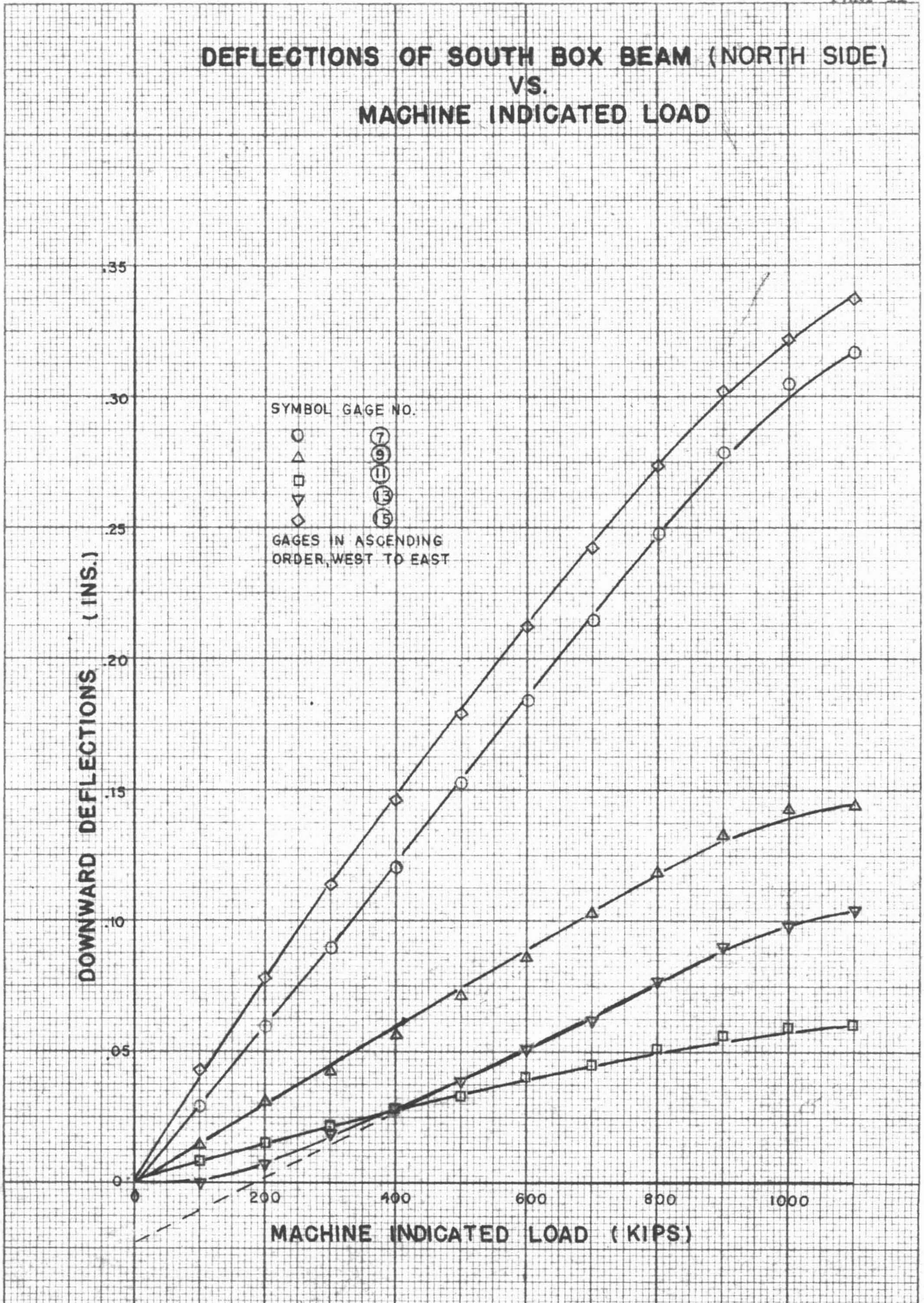

END SPAN AND CENTER DEFLECTIONS
VS.
MACHINE INDICATED LOAD
SYMBOL GAGE NO. LOCATION
17 WEST END OF END SPAN
18 CENTER OF END SPAN
19 EAST END OF END SPAN
20 CENTER OF PLATFORM
DOWNWARD DEFLECTIONS (INS.)
.875
.750
.625
.500
.375
.250
.125
0
0
200
400
600
800
1000
MACHINE INDICATED LOAD (KIPS)

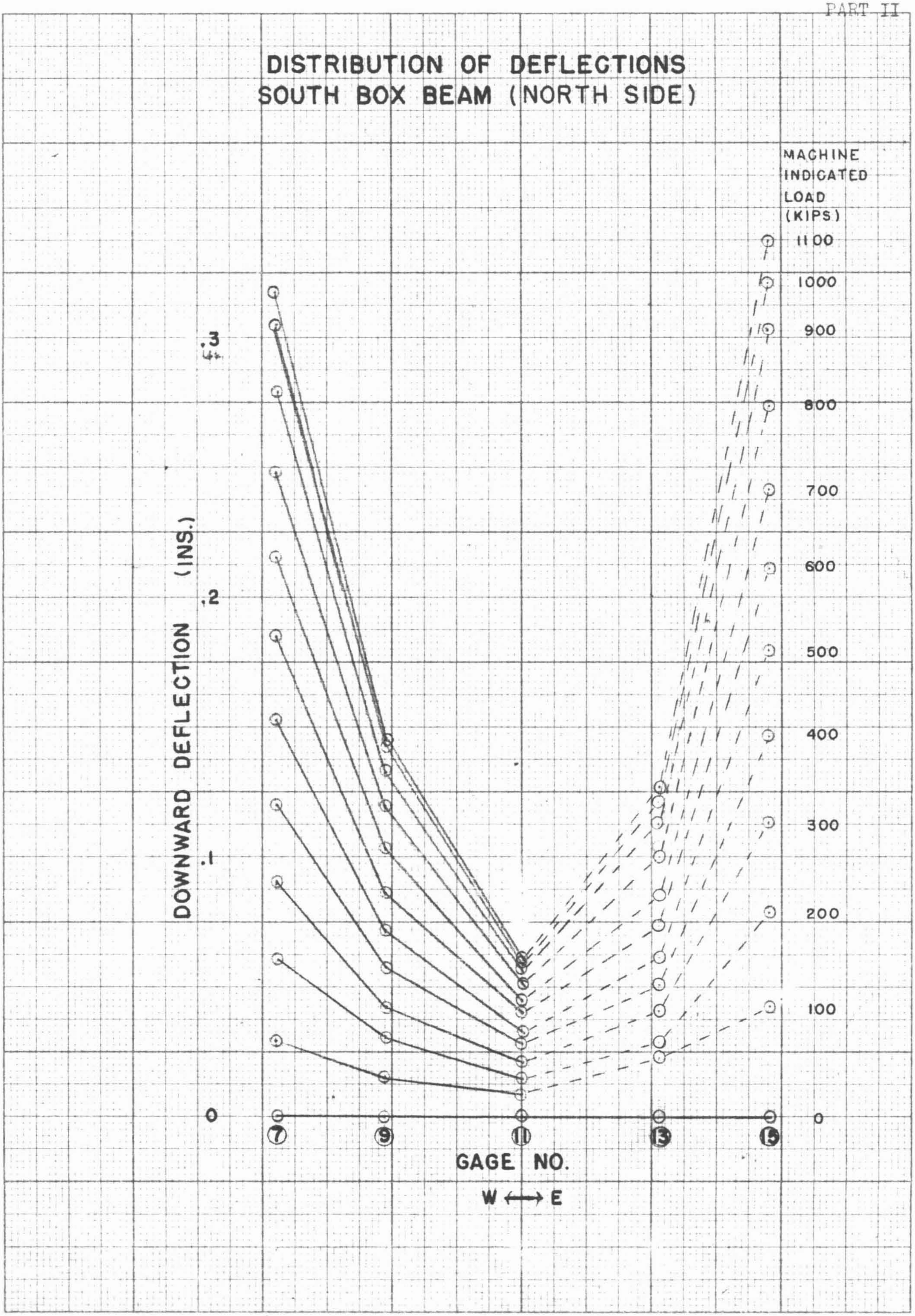

SOUTH HANGER BOLT BOTTOM DEFLECTIONS
VS.
MACHINE INDICATED LOAD
SYMBOL GAGE NO.
1
2
3
4
5
6
GAGES IN ASCENDING
ORDER, WEST TO EAST
DEFLECTION (INS.)
.096
.080
.064
.048
.032
.016
0
0
200
400
600
800
1000
MACHINE INDICATED LOAD (KIPS)

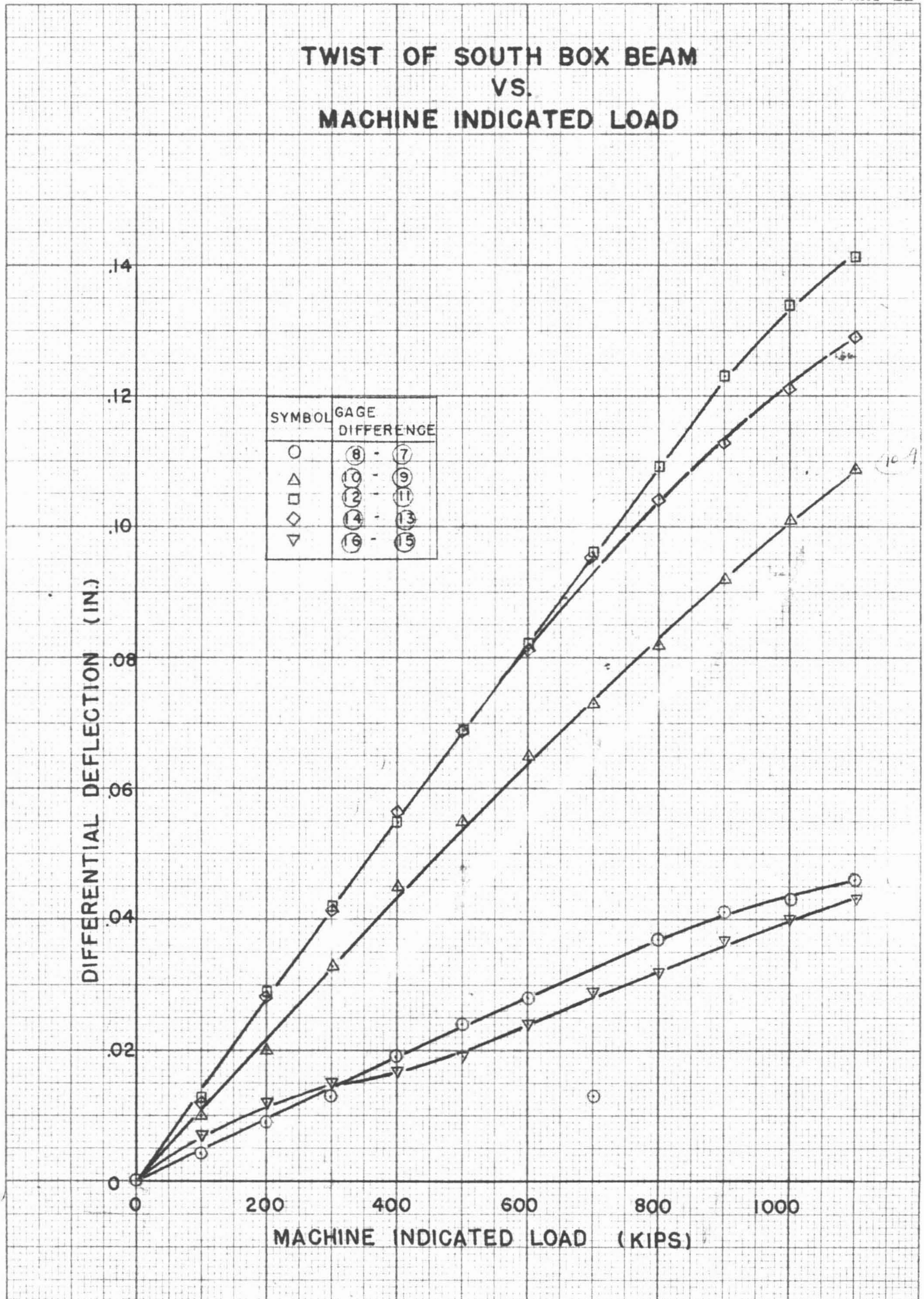

DISTRIBUTION OF BOTTOM DEFLECTIONS
SOUTH HANGER BOLTS
DEFLECTION (INS.)
.10
.08
.06
.04
.02
0
MACHINE INDICATED LOAD (KIPS)
1100
1000
900
800
700
600
500
400
300
200
100
0
1
2
3
4
5
6
GAGE NO.
W ⟷ E

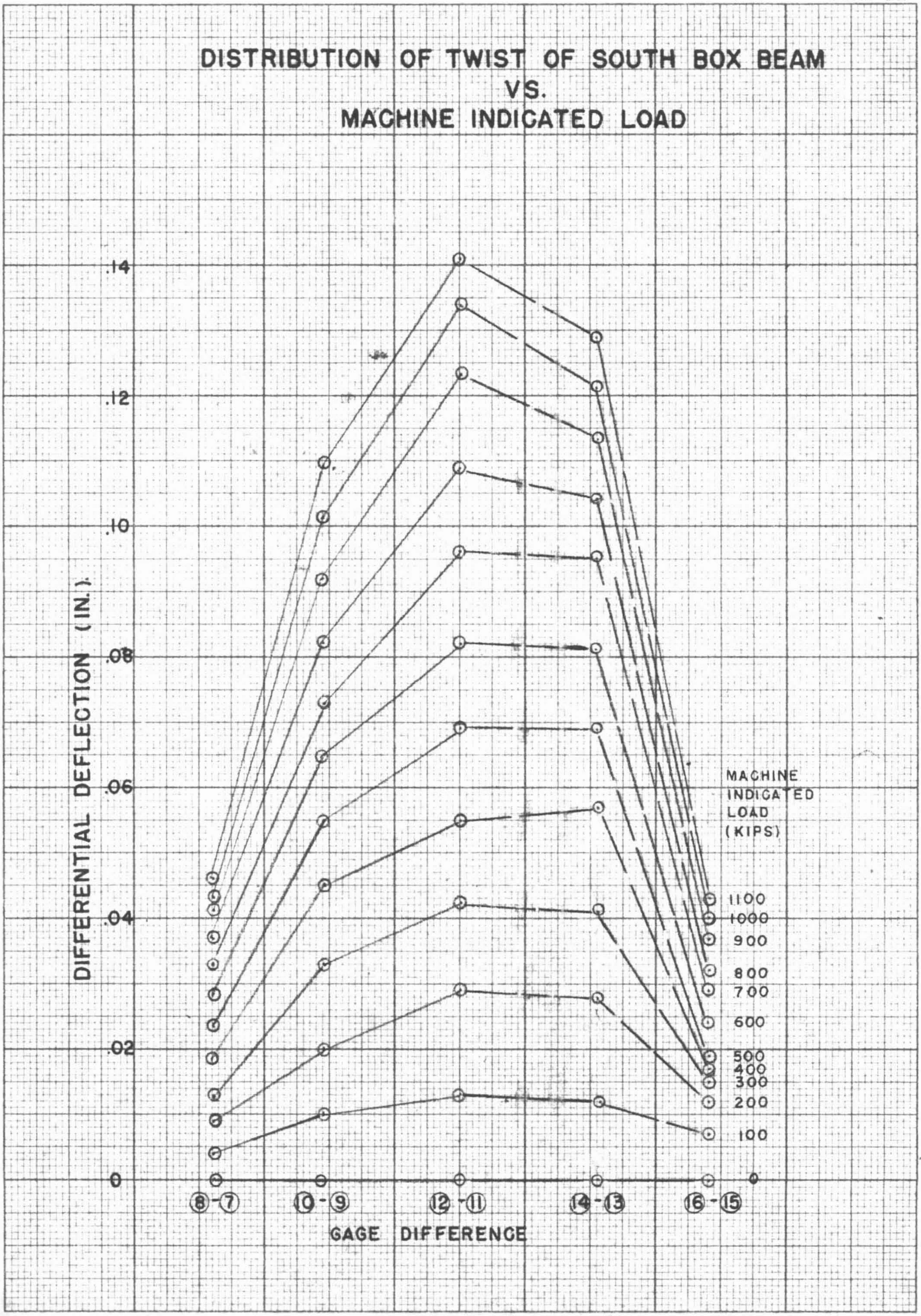

DEFLECTIONS OF SOUTH BOX BEAM (SOUTH SIDE)
VS.
MACHINE INDICATED LOAD
SYMBOL GAGE NO.
8
10
12
14
16
GAGES IN ASCENDING ORDER, WEST TO EAST
DOWNWARD DEFLECTIONS (INS.)
MACHINE INDICATED LOAD (KIPS)
0
.05
.10
.15
.20
.25
.30
.35
.40
0
200
400
600
800
1000
20 X 20 PER INCH
MADE IN U. S. A.

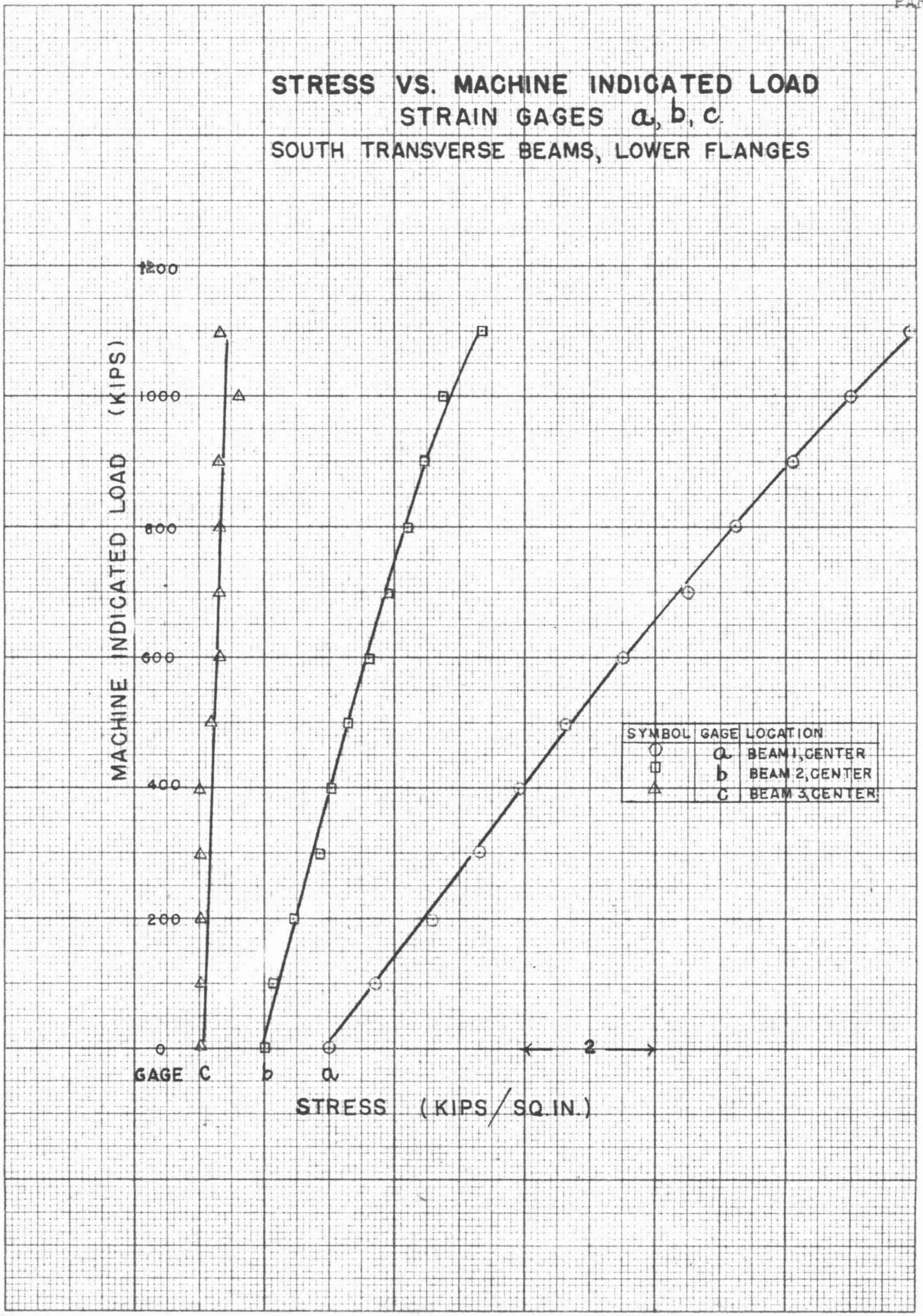

DISTRIBUTION OF DEFLECTIONS
SOUTH BOX BEAM (SOUTH SIDE)
DOWNWARD DEFLECTION (INS.)
.4
.3
.2
.1
0
MACHINE INDICATED LOAD (KIPS)
1100
1000
900
800
700
600
500
400
300
200
100
0
8
10
12
14
16
GAGE NO.
W ⟷ E

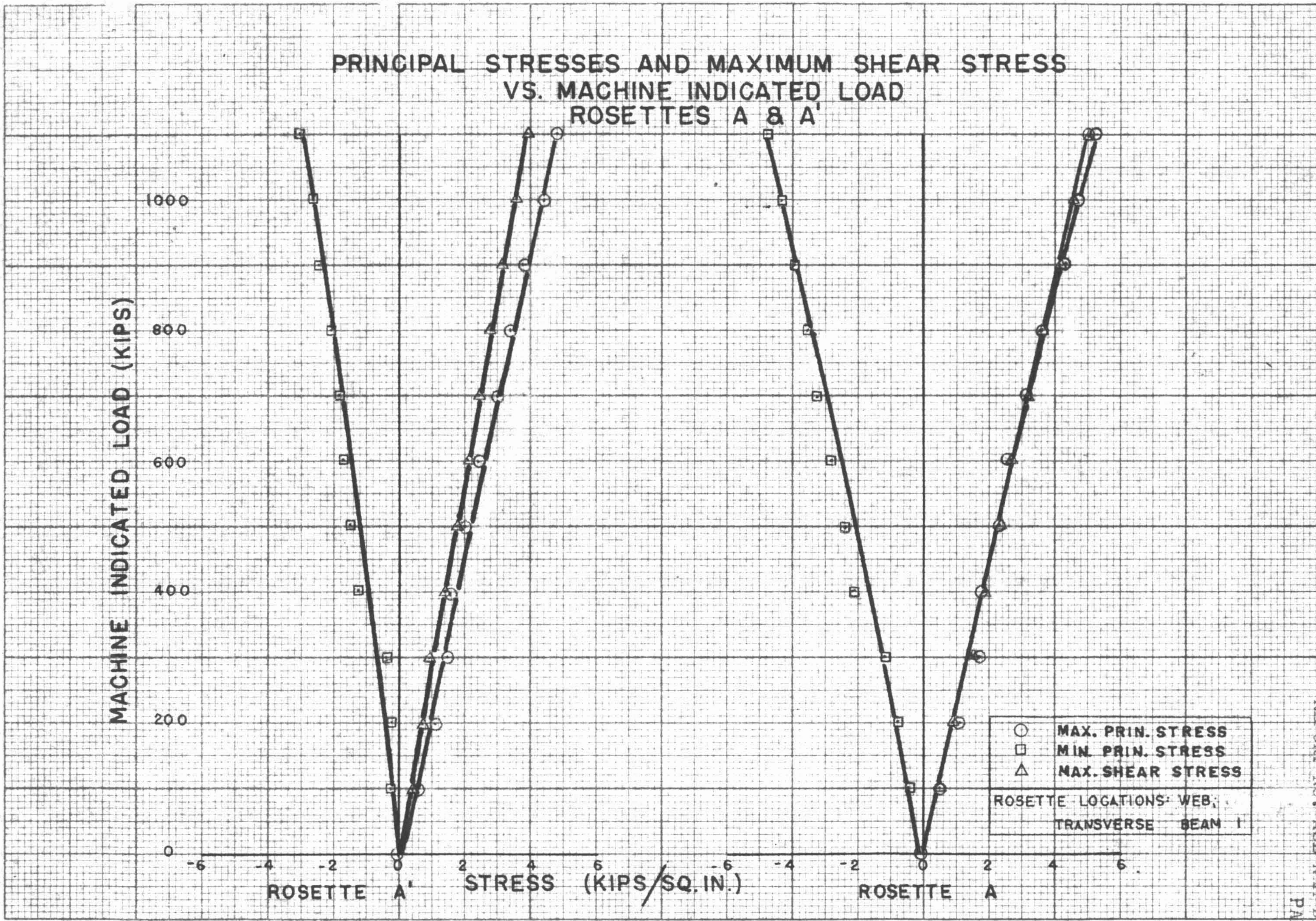

DEFLECTIONS OF SOUTH BOX BEAM (NORTH SIDE)
VS.
MACHINE INDICATED LOAD
SYMBOL GAGE NO.
7
9
11
13
15
GAGES IN ASCENDING ORDER, WEST TO EAST
DOWNWARD DEFLECTIONS (INS.)
MACHINE INDICATED LOAD (KIPS)
0
.05
.10
.15
.20
.25
.30
.35
200
400
600
800
1000


DISTRIBUTION OF DEFLECTIONS
SOUTH BOX BEAM (NORTH SIDE)
MACHINE
INDICATED
LOAD
(KIPS)
1100
1000
900
800
700
600
500
400
300
200
100
0
DOWNWARD DEFLECTION (INS.)
.3
.2
.1
0
7
9
11
13
15
GAGE NO.
W ⟷ E

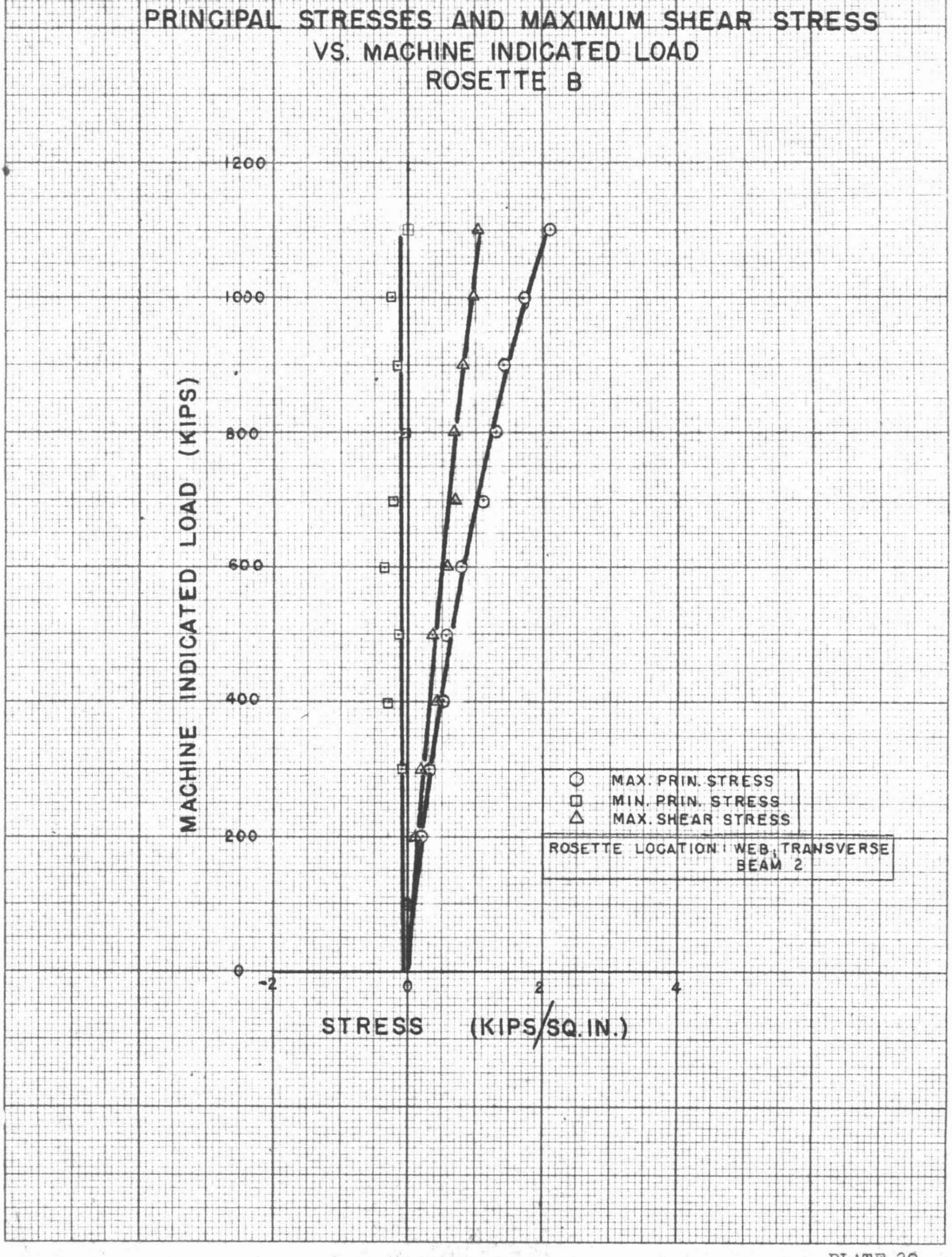

TWIST OF SOUTH BOX BEAM
VS.
MACHINE INDICATED LOAD
SYMBOL
GAGE DIFFERENCE
8 - 7
10 - 9
12 - 11
14 - 13
16 - 15
DIFFERENTIAL DEFLECTION (IN.)
0
.02
.04
.06
.08
.10
.12
.14
0
200
400
600
800
1000
MACHINE INDICATED LOAD (KIPS)


DISTRIBUTION OF TWIST OF SOUTH BOX BEAM
VS.
MACHINE INDICATED LOAD
DIFFERENTIAL DEFLECTION (IN.)
.14
.12
.10
.08
.06
.04
.02
0
⑧-⑦
⑩-⑨
⑫-⑪
⑭-⑬
⑯-⑮
GAGE DIFFERENCE
MACHINE INDICATED LOAD (KIPS)
1100
1000
900
800
700
600
500
400
300
200
100
0

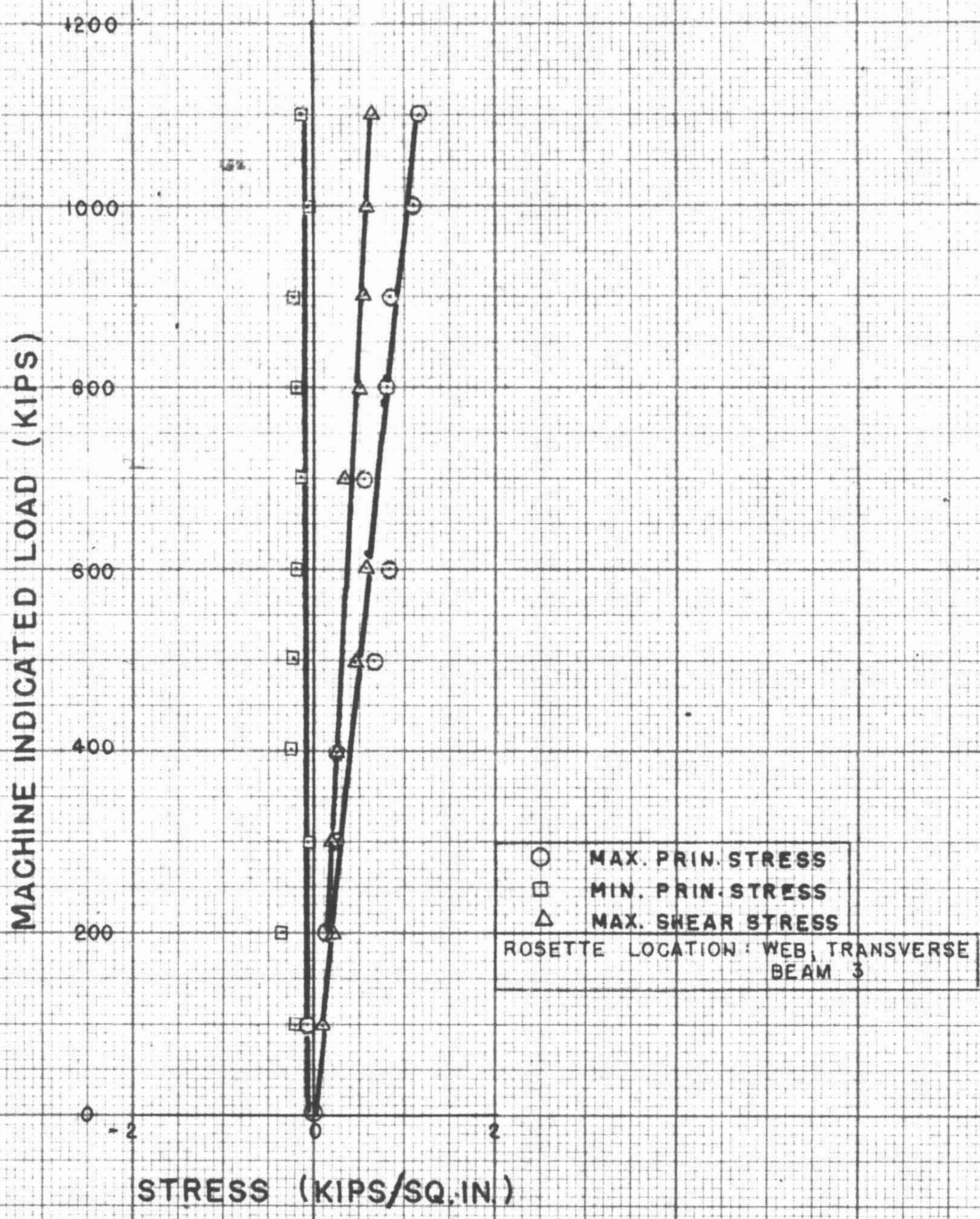

STRESS VS. MACHINE INDICATED LOAD
STRAIN GAGES a, b, c
SOUTH TRANSVERSE BEAMS, LOWER FLANGES
MACHINE INDICATED LOAD (KIPS)
1200
1000
800
600
400
200
0
GAGE C b a
STRESS (KIPS/SQ.IN.)
2
SYMBOL GAGE LOCATION
a BEAM 1, CENTER
b BEAM 2, CENTER
C BEAM 3, CENTER
20 X 20 PER INCH



PRINCIPAL STRESSES AND MAXIMUM SHEAR STRESS
VS. MACHINE INDICATED LOAD
ROSETTES A & A'
MACHINE INDICATED LOAD (KIPS)
1000
800
600
400
200
0
-6
-4
-2
0
2
4
6
STRESS (KIPS/SQ. IN.)
ROSETTE A'
ROSETTE A
MAX. PRIN. STRESS
MIN. PRIN. STRESS
MAX. SHEAR STRESS
ROSETTE LOCATIONS: WEB,
TRANSVERSE BEAM I


PRINCIPAL STRESSES AND MAXIMUM SHEAR STRESS
VS. MACHINE INDICATED LOAD
ROSETTE B
MACHINE INDICATED LOAD (KIPS)
1200
1000
800
600
400
200
0
-2
0
2
4
STRESS (KIPS/SQ. IN.)
MAX. PRIN. STRESS
MIN. PRIN. STRESS
MAX. SHEAR STRESS
ROSETTE LOCATION: WEB, TRANSVERSE
BEAM 2

PRINCIPAL STRESSES AND MAXIMUM SHEAR STRESS
VS. MACHINE INDICATED LOAD
ROSETTE C



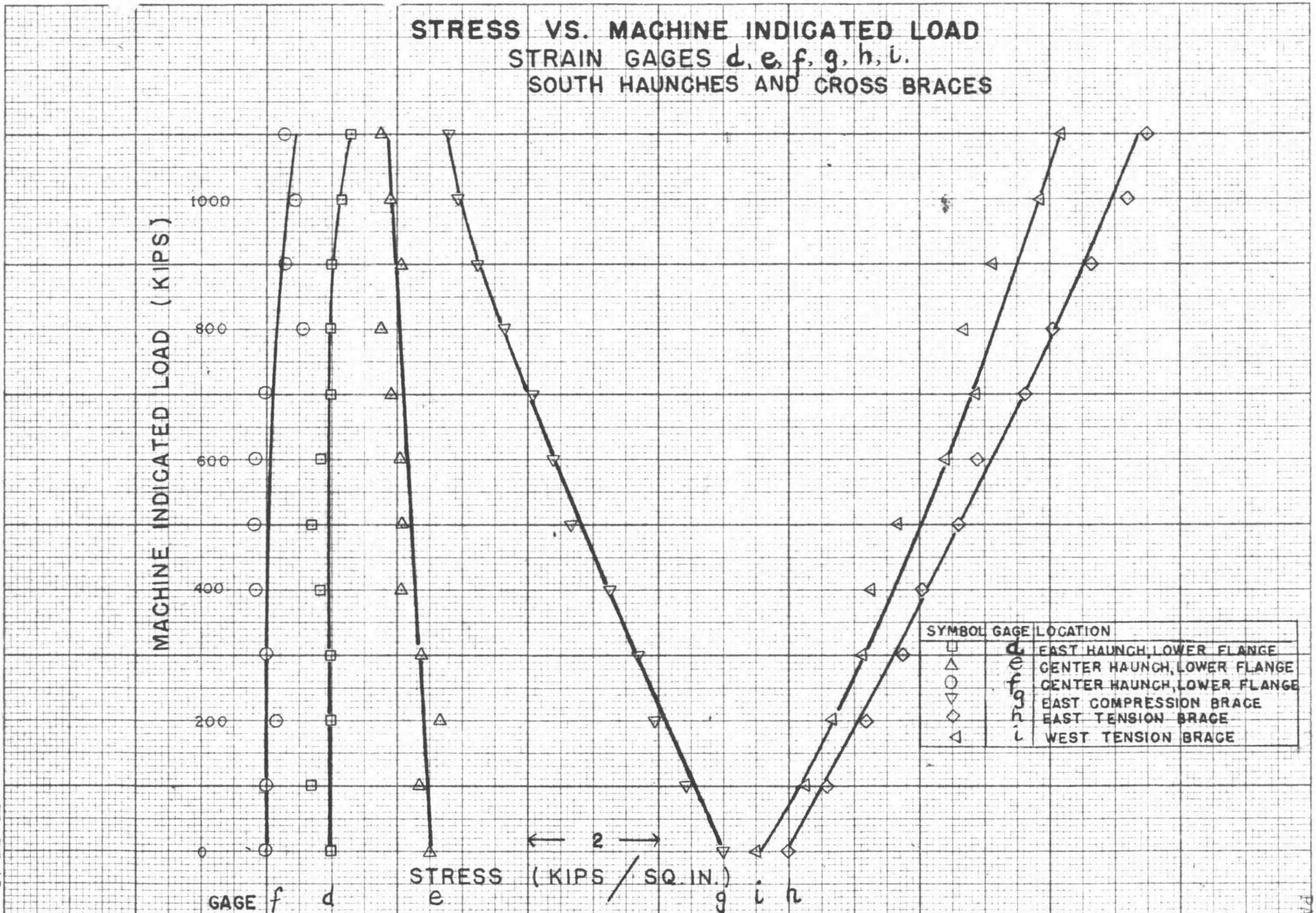
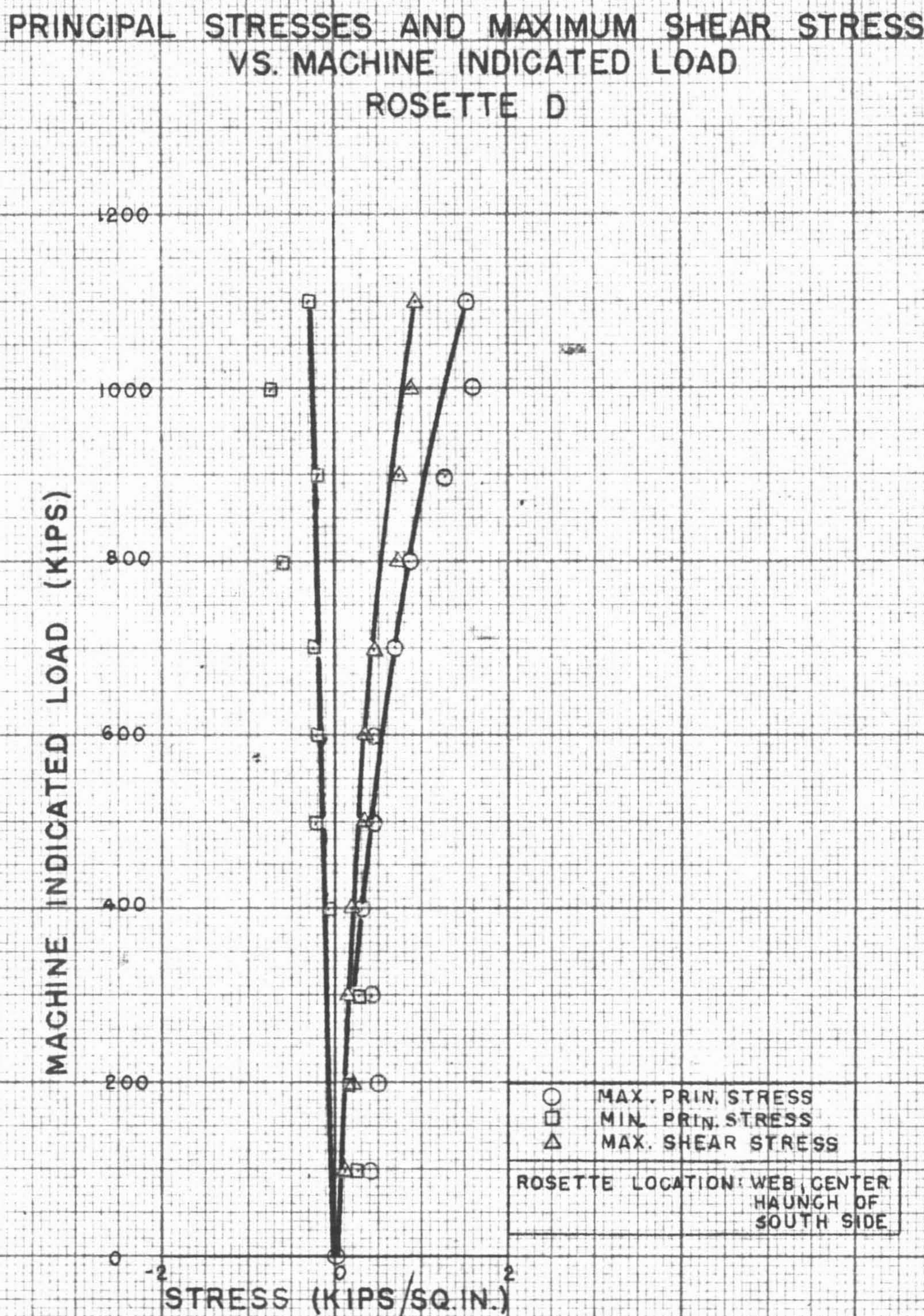


PLATE 41

REPORT NO. ASL NAM DE-223 PART II



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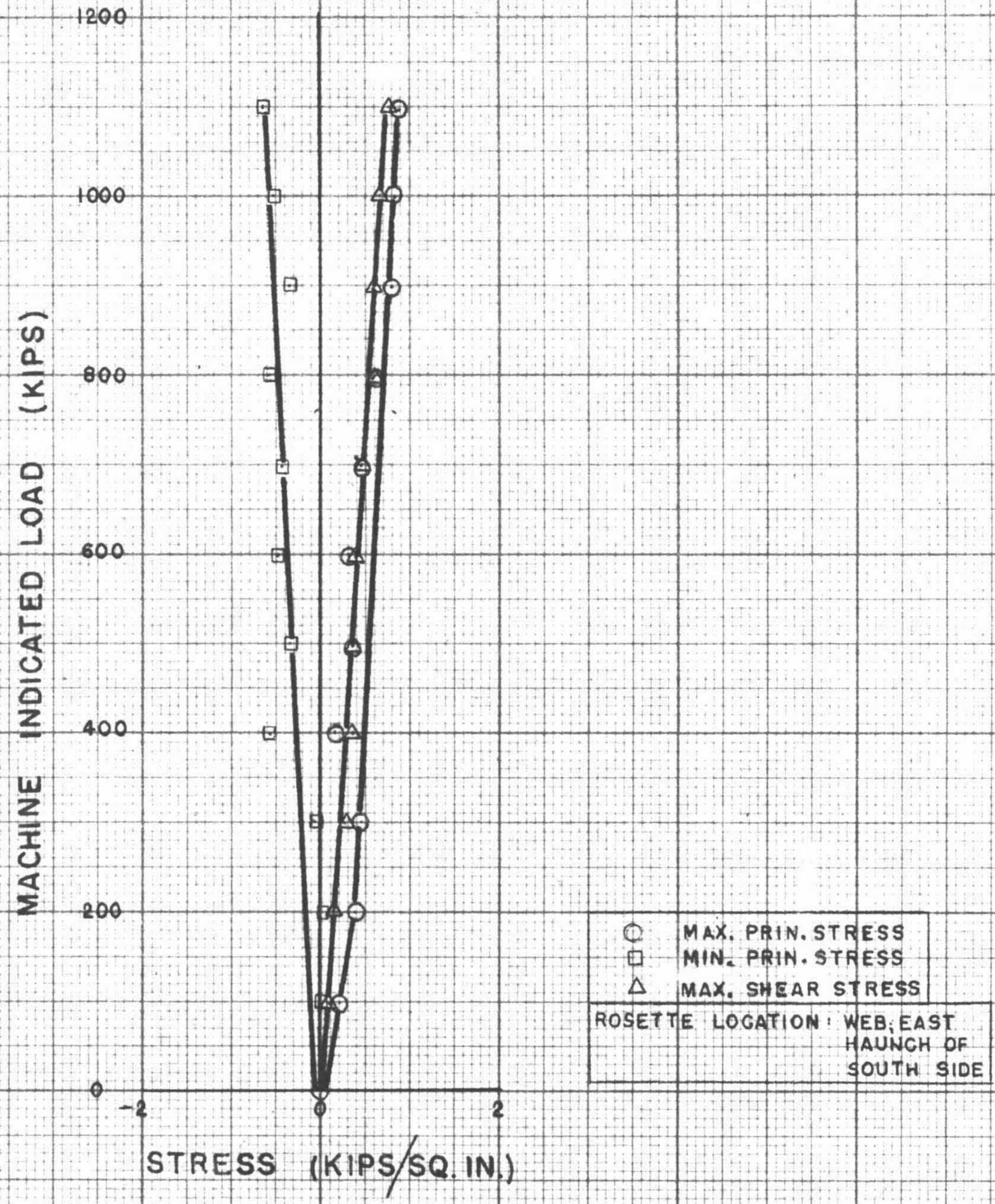
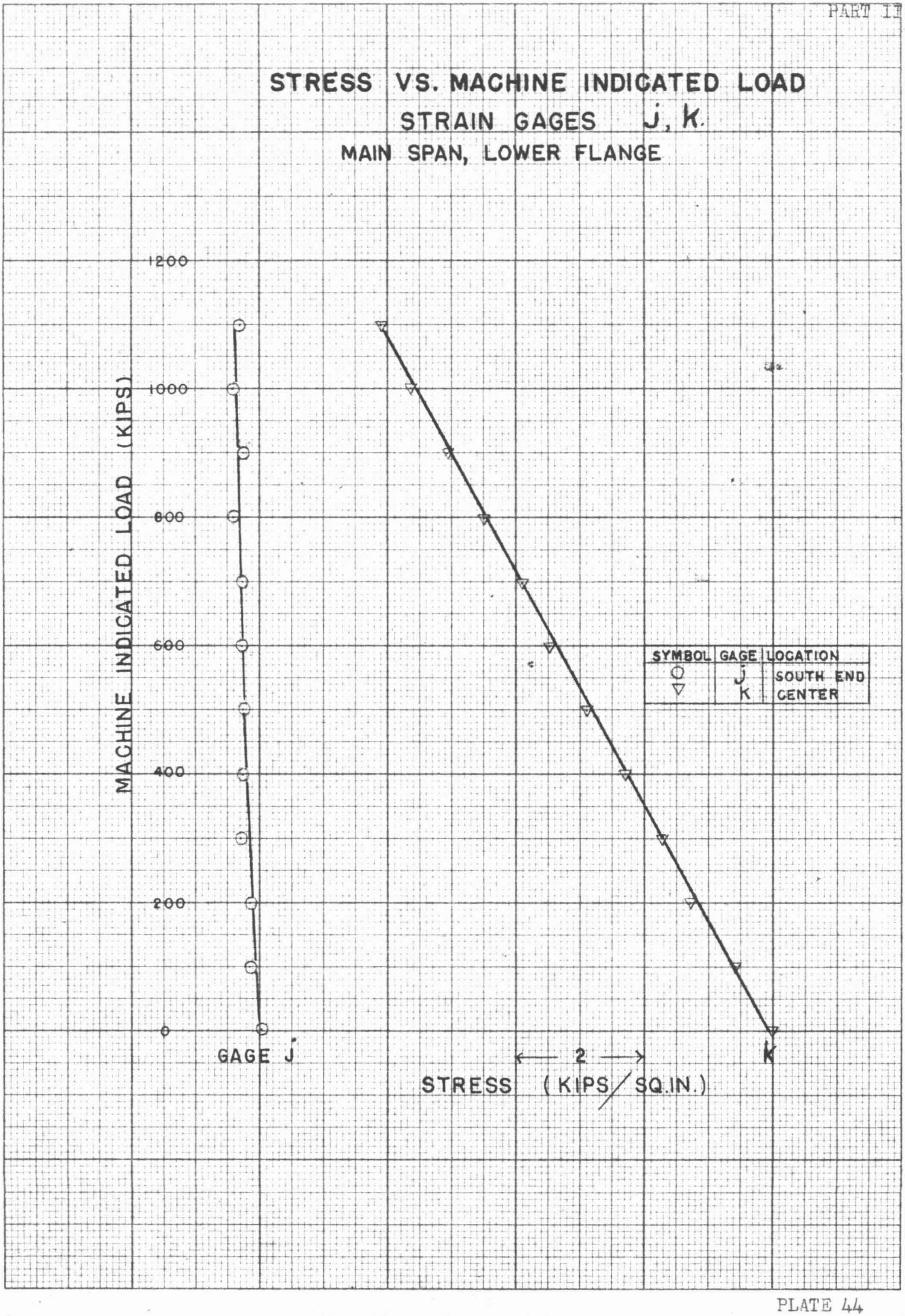
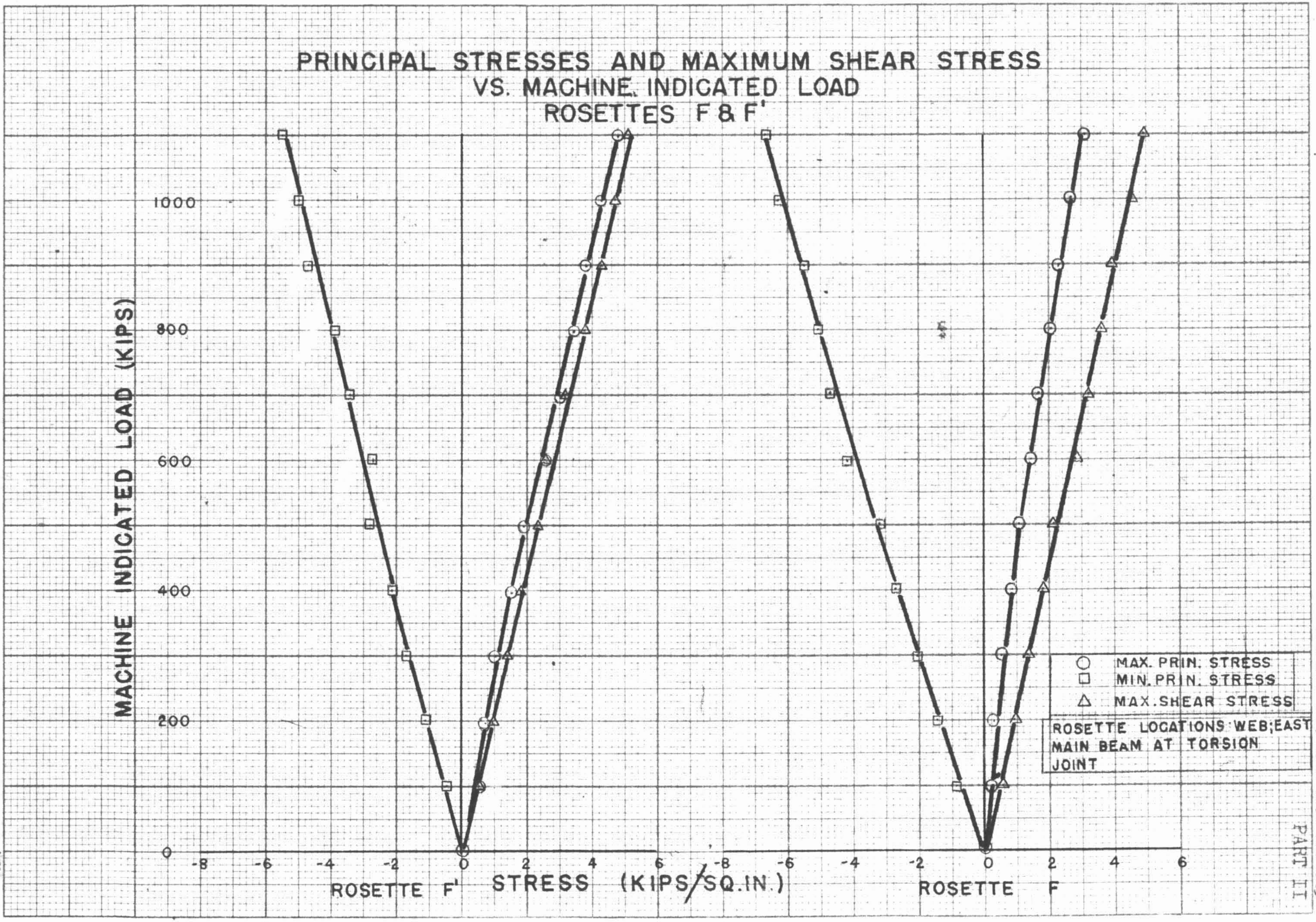
PRINCIPAL STRESSES AND MAXIMUM SHEAR STRESS VS. MACHINE INDICATED LOAD ROSETTE E




STRESS VS. MACHINE INDICATED LOAD
STRAIN GAGES j, k.
MAIN SPAN, LOWER FLANGE
MACHINE INDICATED LOAD (KIPS)
1200
1000
800
600
400
200
0
GAGE j
k
← 2 →
STRESS (KIPS/SQ.IN.)
SYMBOL
GAGE
LOCATION
j
SOUTH END
k
CENTER


PRINCIPAL STRESSES AND MAXIMUM SHEAR STRESS
VS. MACHINE INDICATED LOAD
ROSETTES F & F'
MACHINE INDICATED LOAD (KIPS)
0
200
400
600
800
1000
-8
-6
-4
-2
0
2
4
6
-8
-6
-4
-2
0
2
4
6
ROSETTE F'
STRESS (KIPS/SQ.IN.)
ROSETTE F
MAX. PRIN. STRESS
MIN. PRIN. STRESS
MAX. SHEAR STRESS
ROSETTE LOCATIONS WEB; EAST MAIN BEAM AT TORSION JOINT

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20 X 20 PER INCH

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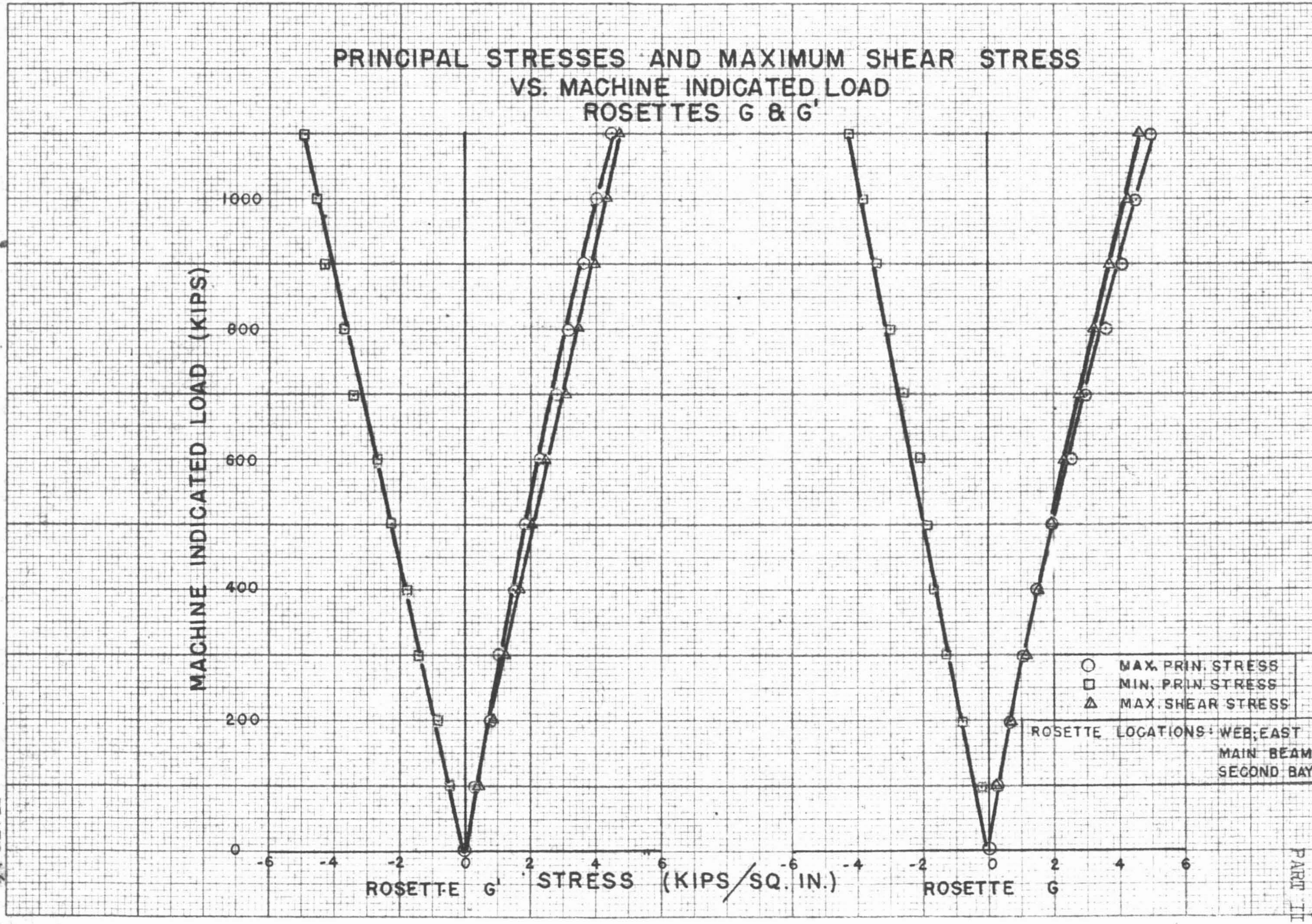
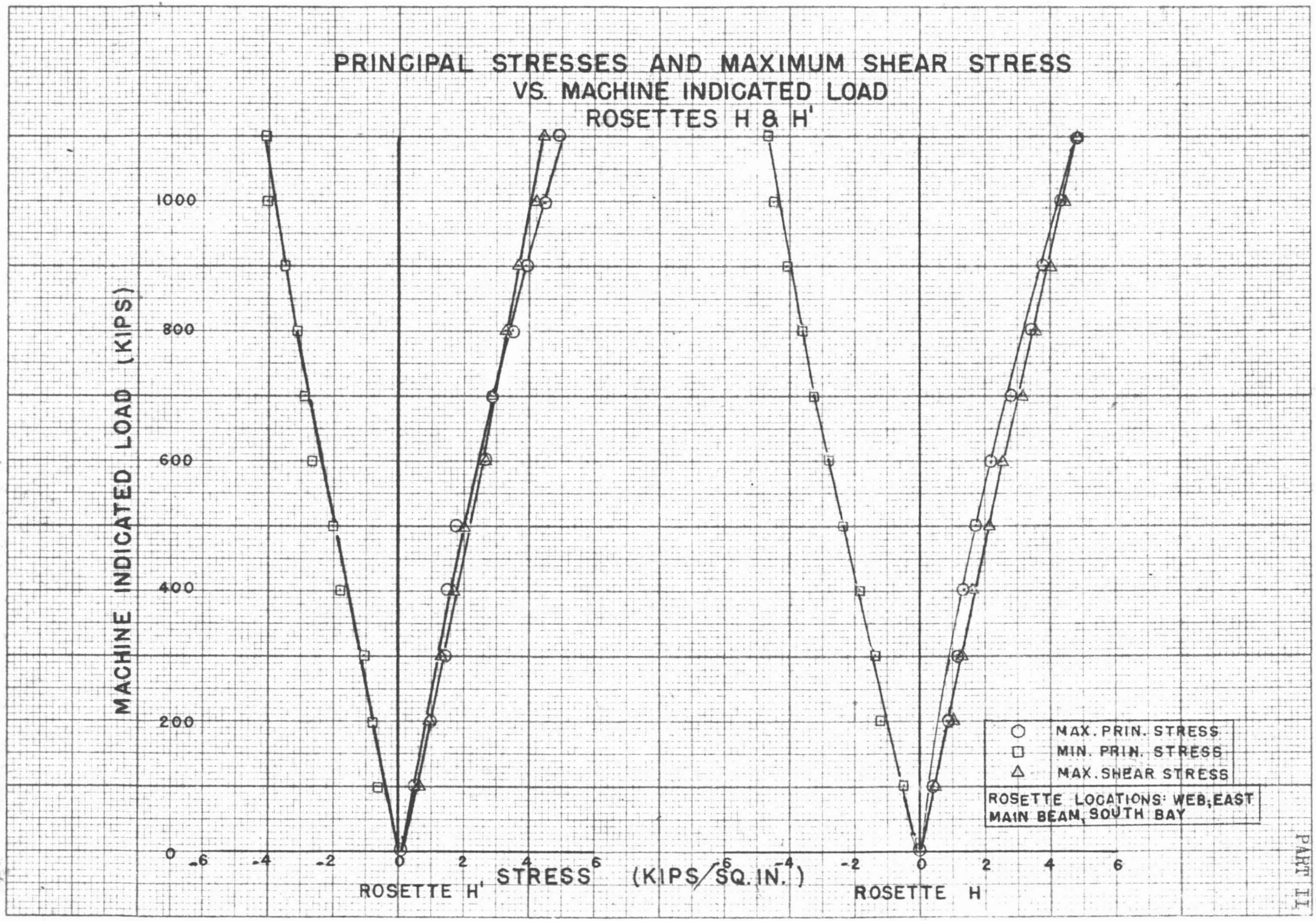
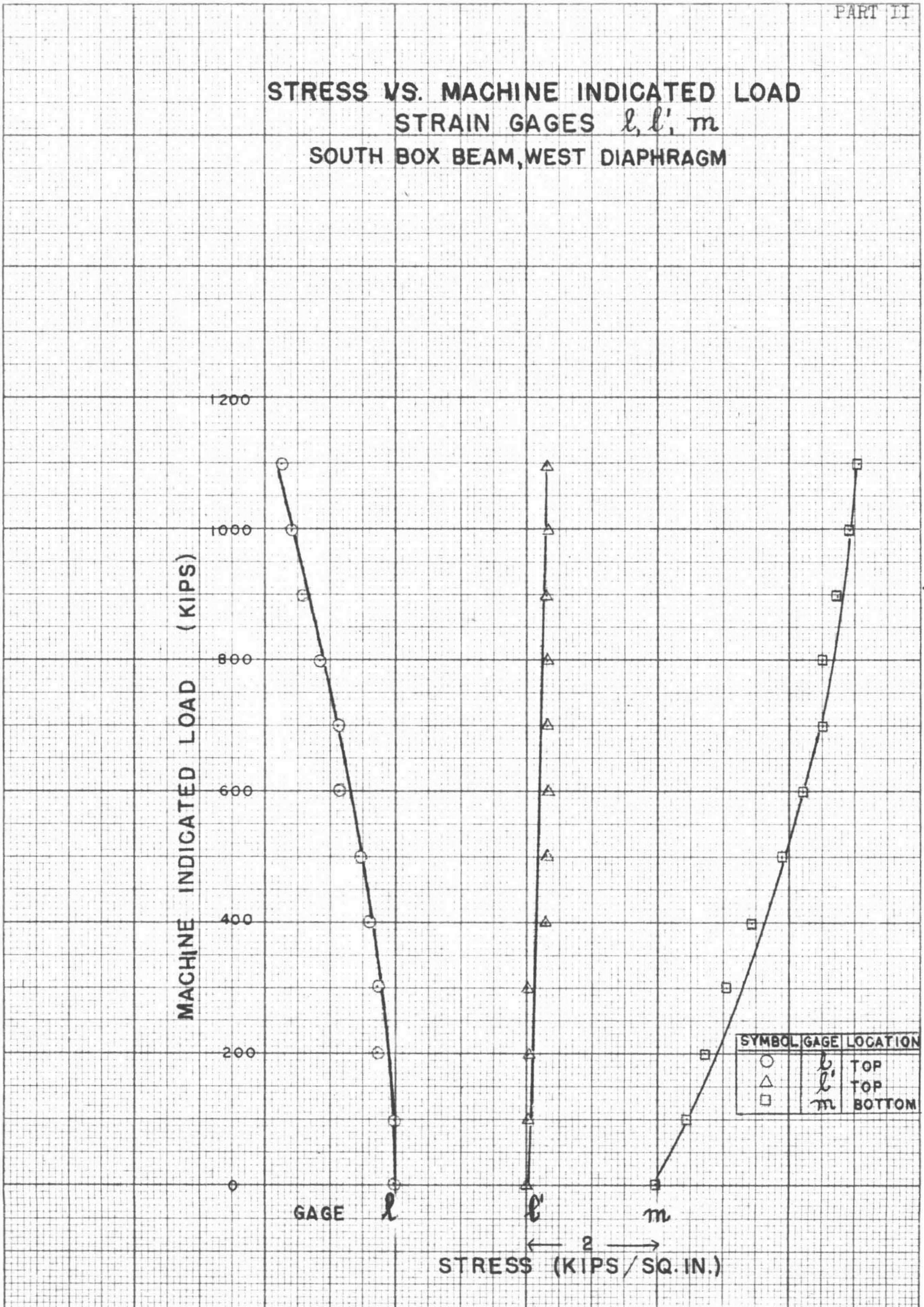
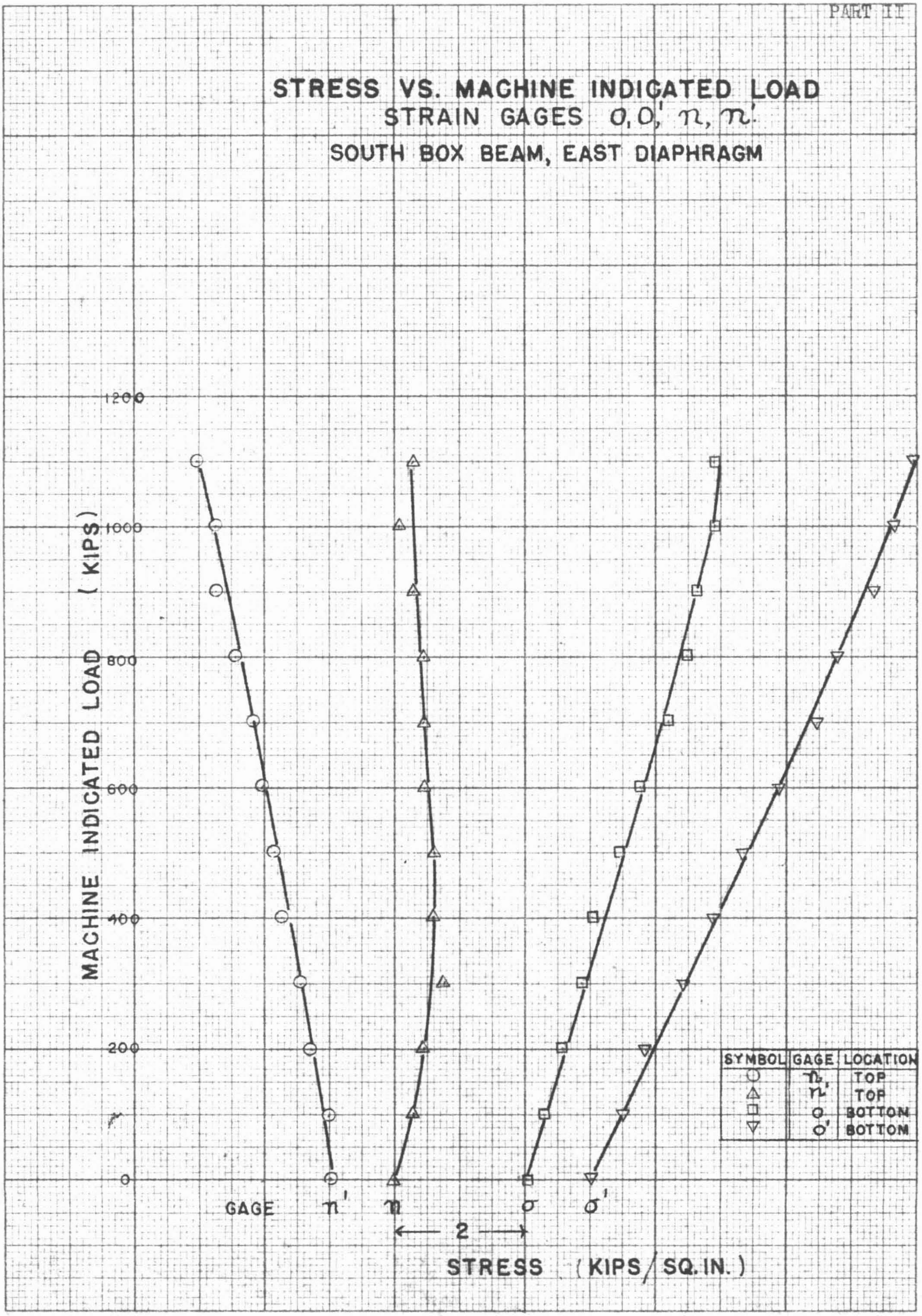


PLATE 46

REPORT NO. ASL NAM DE-223
PART II


PRINCIPAL STRESSES AND MAXIMUM SHEAR STRESS
VS. MACHINE INDICATED LOAD
ROSETTES H & H'
MACHINE INDICATED LOAD (KIPS)
0
200
400
600
800
1000
-6
-4
-2
0
2
4
6
STRESS (KIPS/SQ. IN.)
ROSETTE H'
ROSETTE H
MAX. PRIN. STRESS
MIN. PRIN. STRESS
MAX. SHEAR STRESS
ROSETTE LOCATIONS: WEB, EAST MAIN BEAM, SOUTH BAY


STRESS VS. MACHINE INDICATED LOAD
STRAIN GAGES l, l', m
SOUTH BOX BEAM, WEST DIAPHRAGM
MACHINE INDICATED LOAD (KIPS)
1200
1000
800
600
400
200
0
GAGE l l' m
2
STRESS (KIPS/SQ. IN.)
SYMBOL GAGE LOCATION
l TOP
l' TOP
m BOTTOM


STRESS VS. MACHINE INDICATED LOAD
STRAIN GAGES σ, σ', n, n'
SOUTH BOX BEAM, EAST DIAPHRAGM
MACHINE INDICATED LOAD (KIPS)
1200
1000
800
600
400
200
0
GAGE n' n σ σ'
2
STRESS (KIPS/SQ. IN.)
SYMBOL GAGE LOCATION
n TOP
n' TOP
σ BOTTOM
σ' BOTTOM

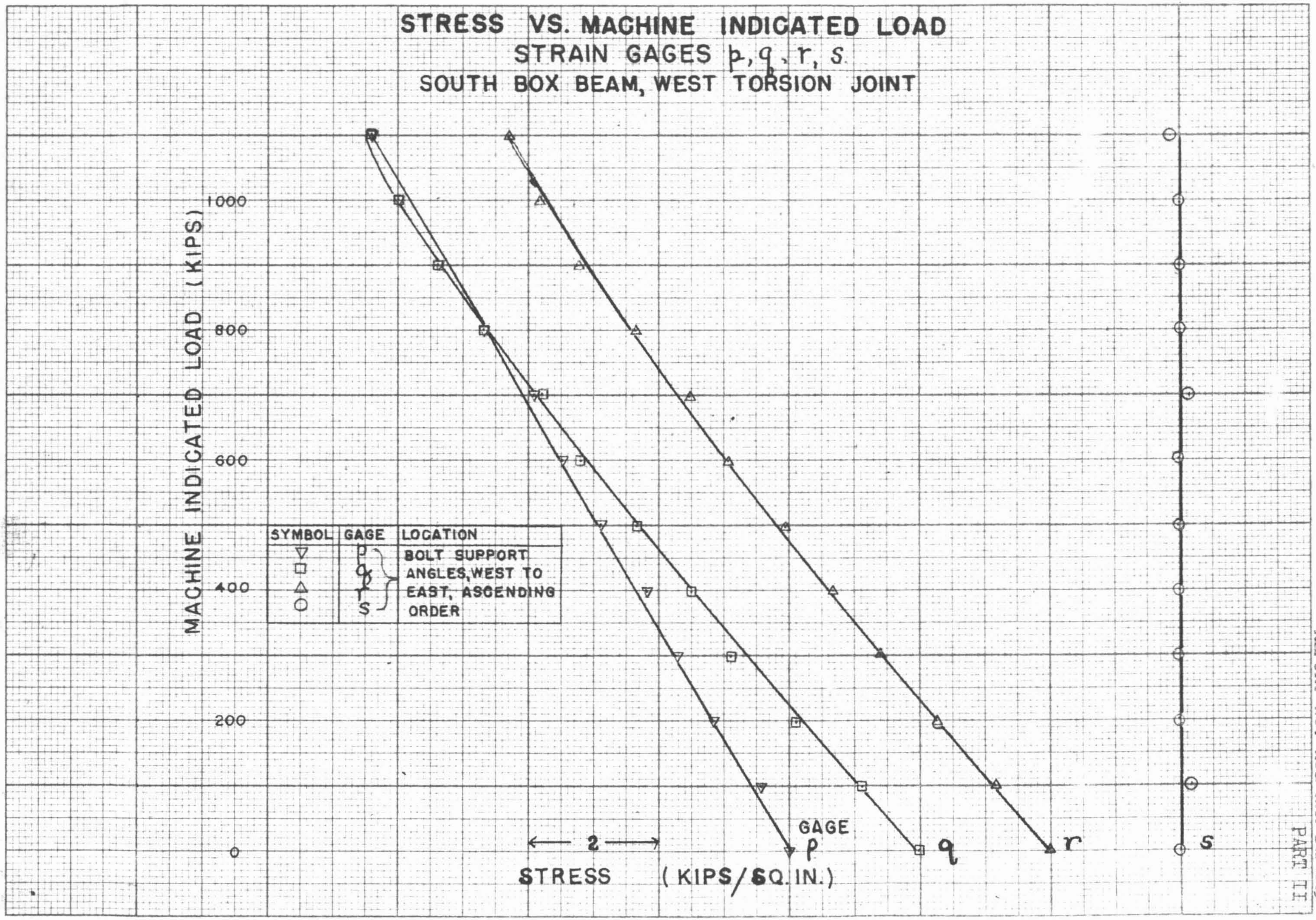
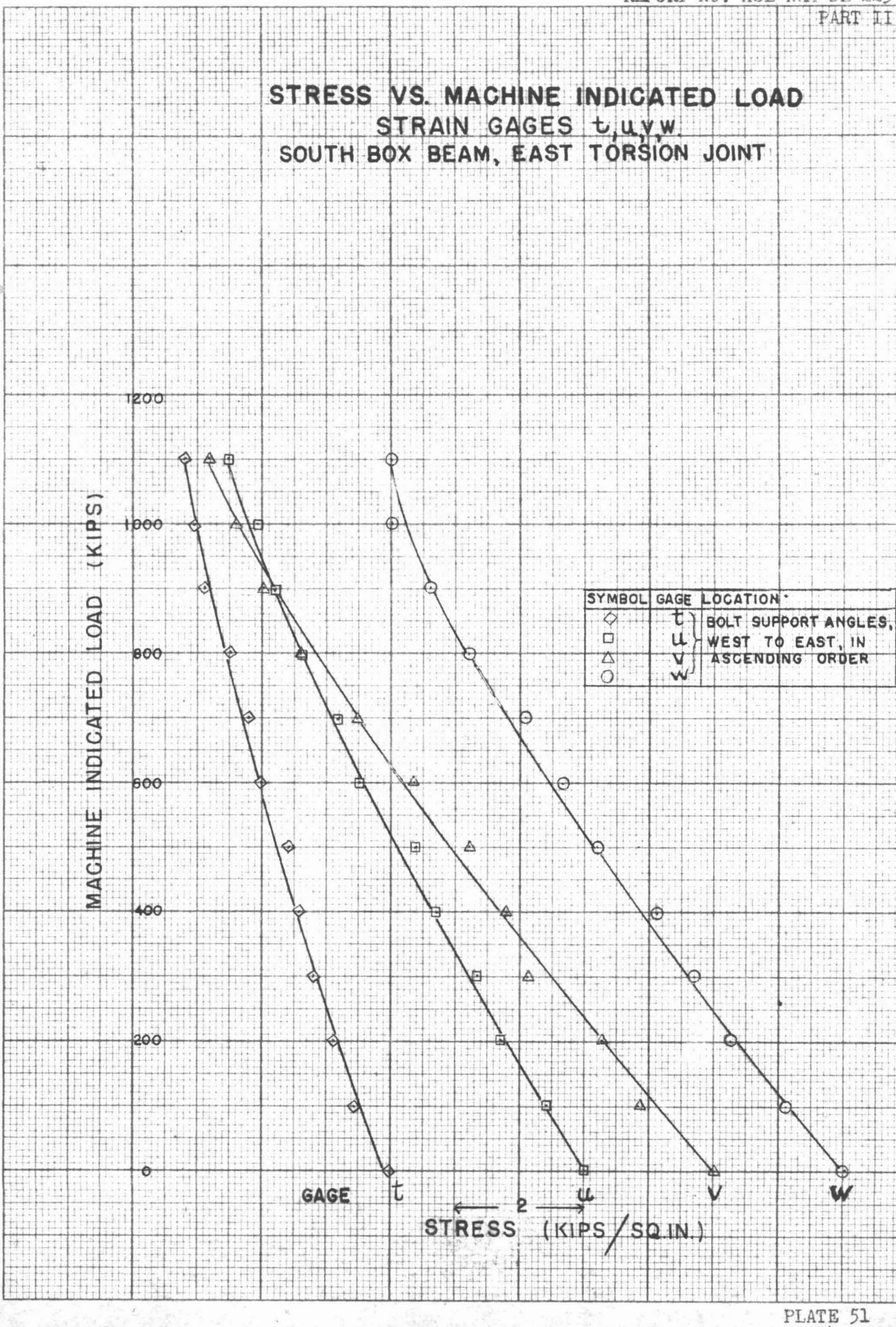
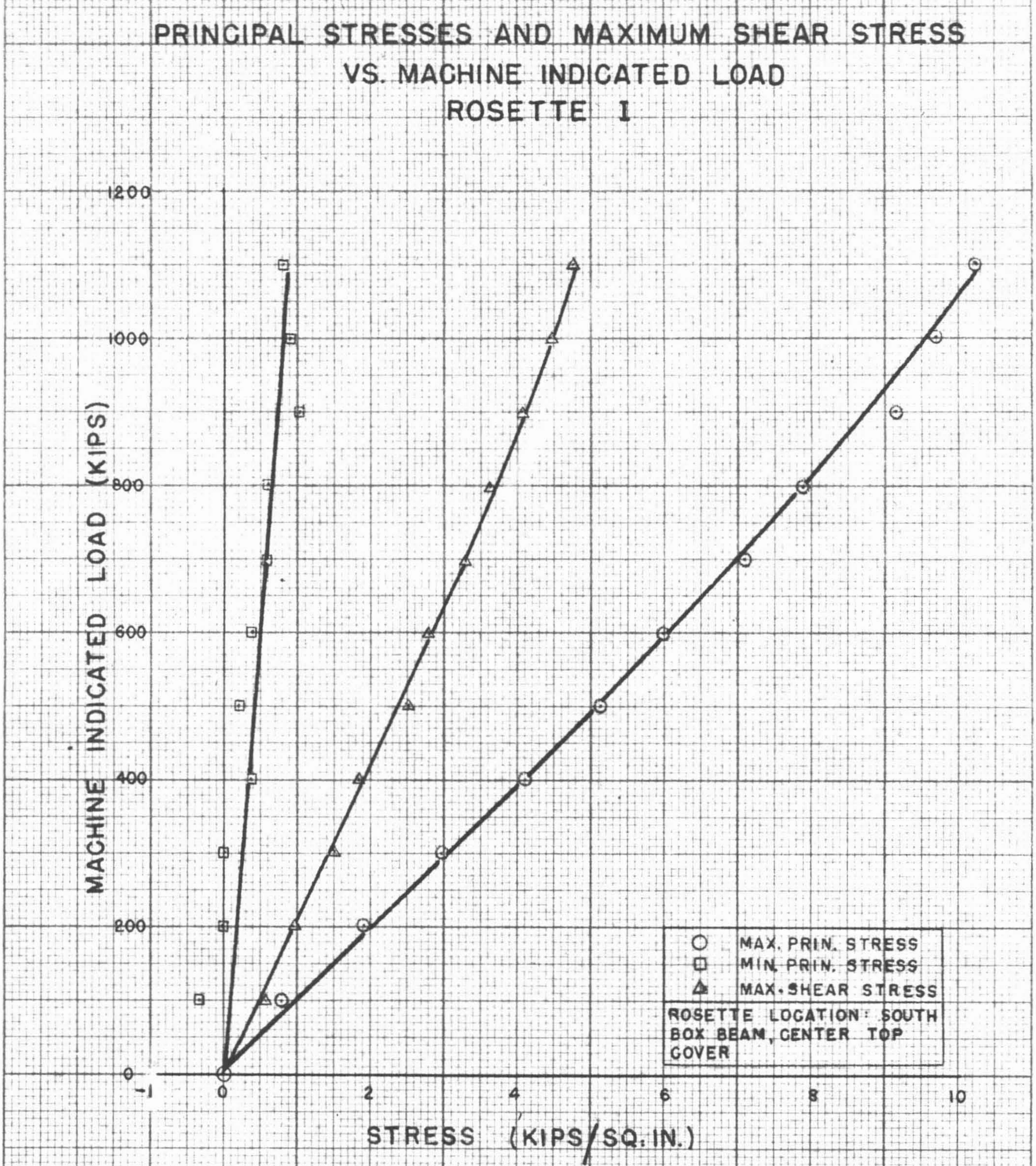
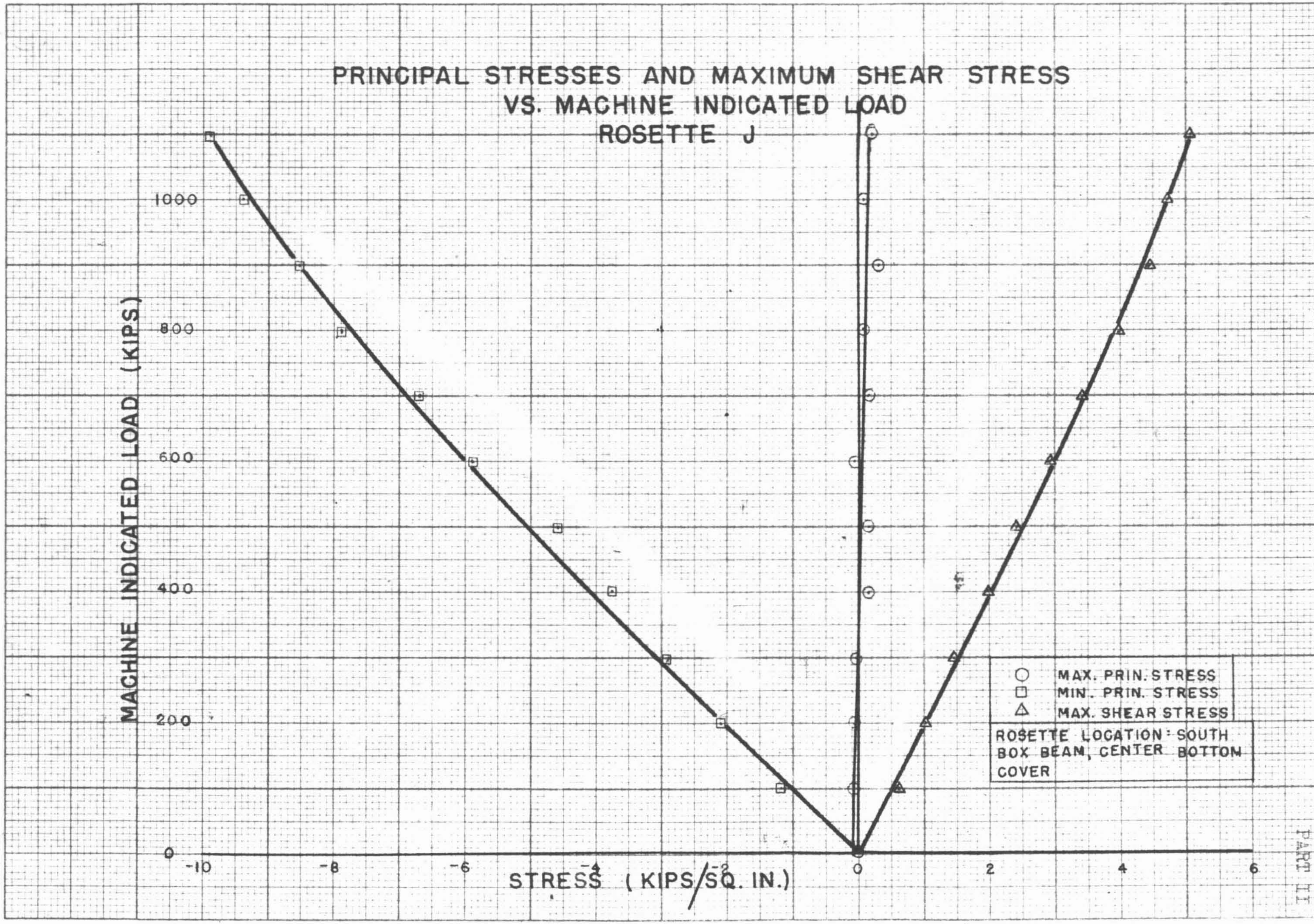


PLATE 50

REPORT NO. ASL NAM DE-223
PART II


STRESS VS. MACHINE INDICATED LOAD
STRAIN GAGES t, u, v, w.
SOUTH BOX BEAM, EAST TORSION JOINT
MACHINE INDICATED LOAD (KIPS)
1200
1000
800
600
400
200
0
SYMBOL
GAGE
LOCATION
t
u
v
w
BOLT SUPPORT ANGLES, WEST TO EAST, IN ASCENDING ORDER
GAGE
t
u
v
w
2
STRESS (KIPS/SQ.IN.)


PRINCIPAL STRESSES AND MAXIMUM SHEAR STRESS
VS. MACHINE INDICATED LOAD
ROSETTE I
MACHINE INDICATED LOAD (KIPS)
1200
1000
800
600
400
200
0
-1
0
2
4
6
8
10
STRESS (KIPS/SQ. IN.)
MAX. PRIN. STRESS
MIN. PRIN. STRESS
MAX. SHEAR STRESS
ROSETTE LOCATION: SOUTH BOX BEAM, CENTER TOP COVER



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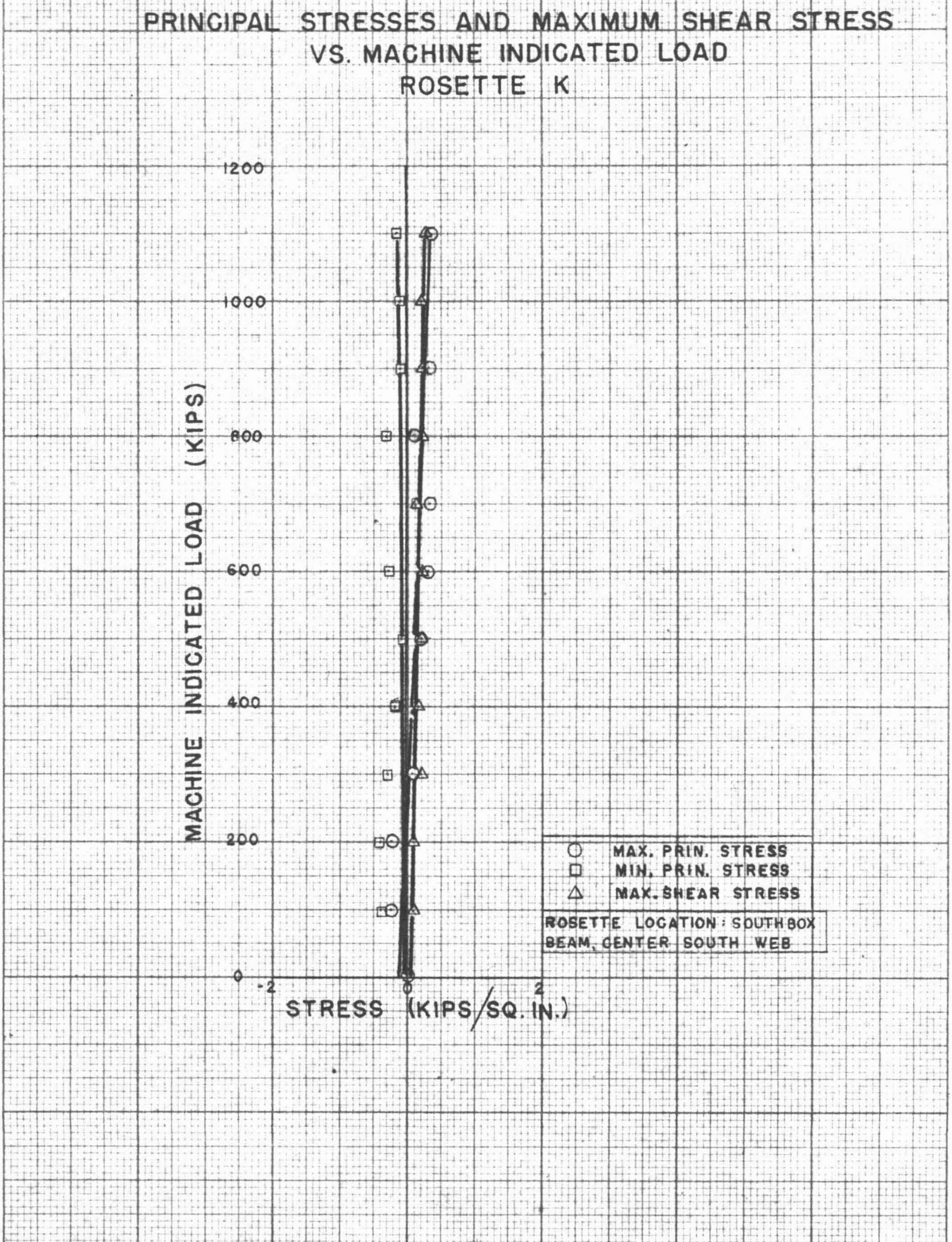
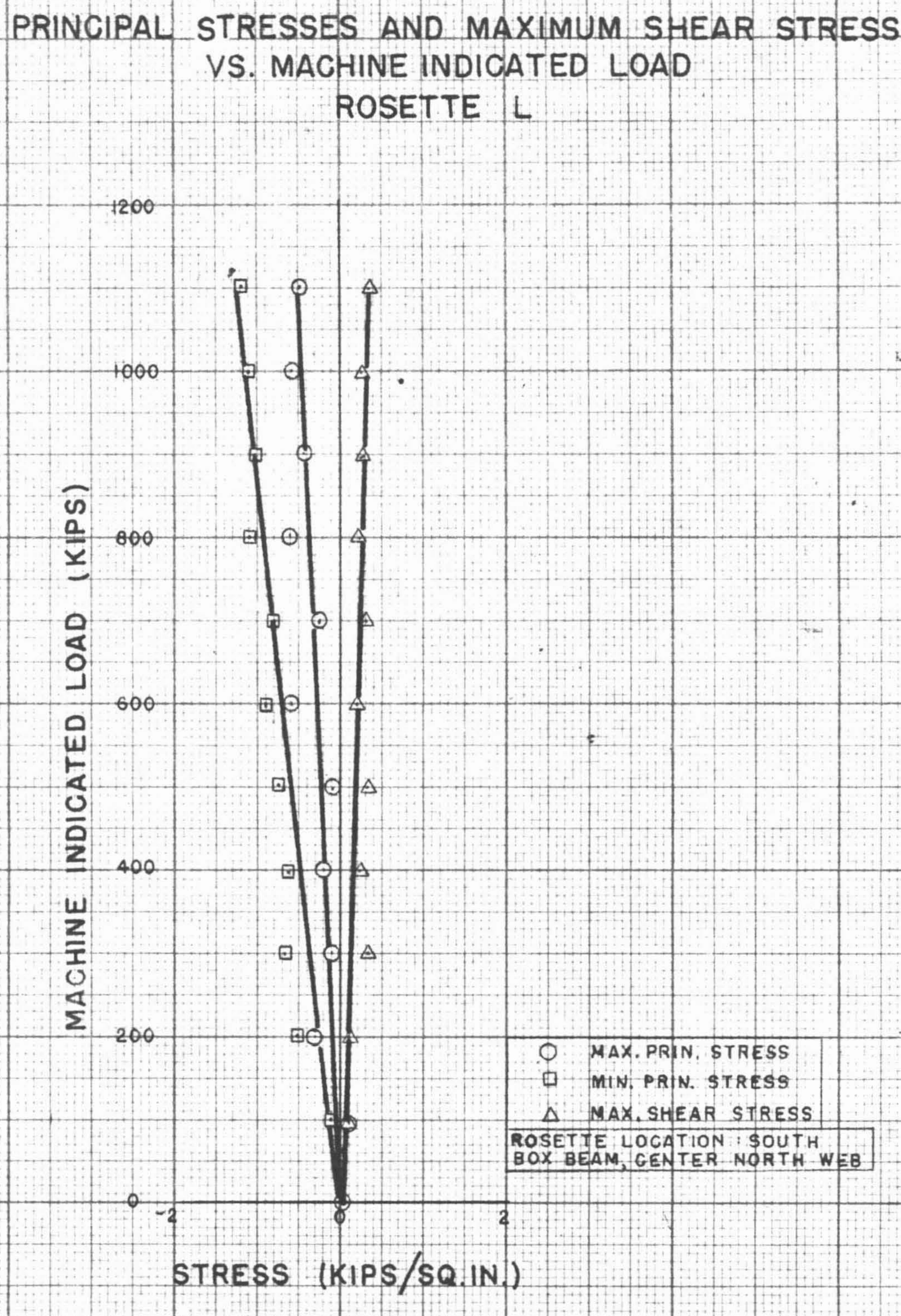
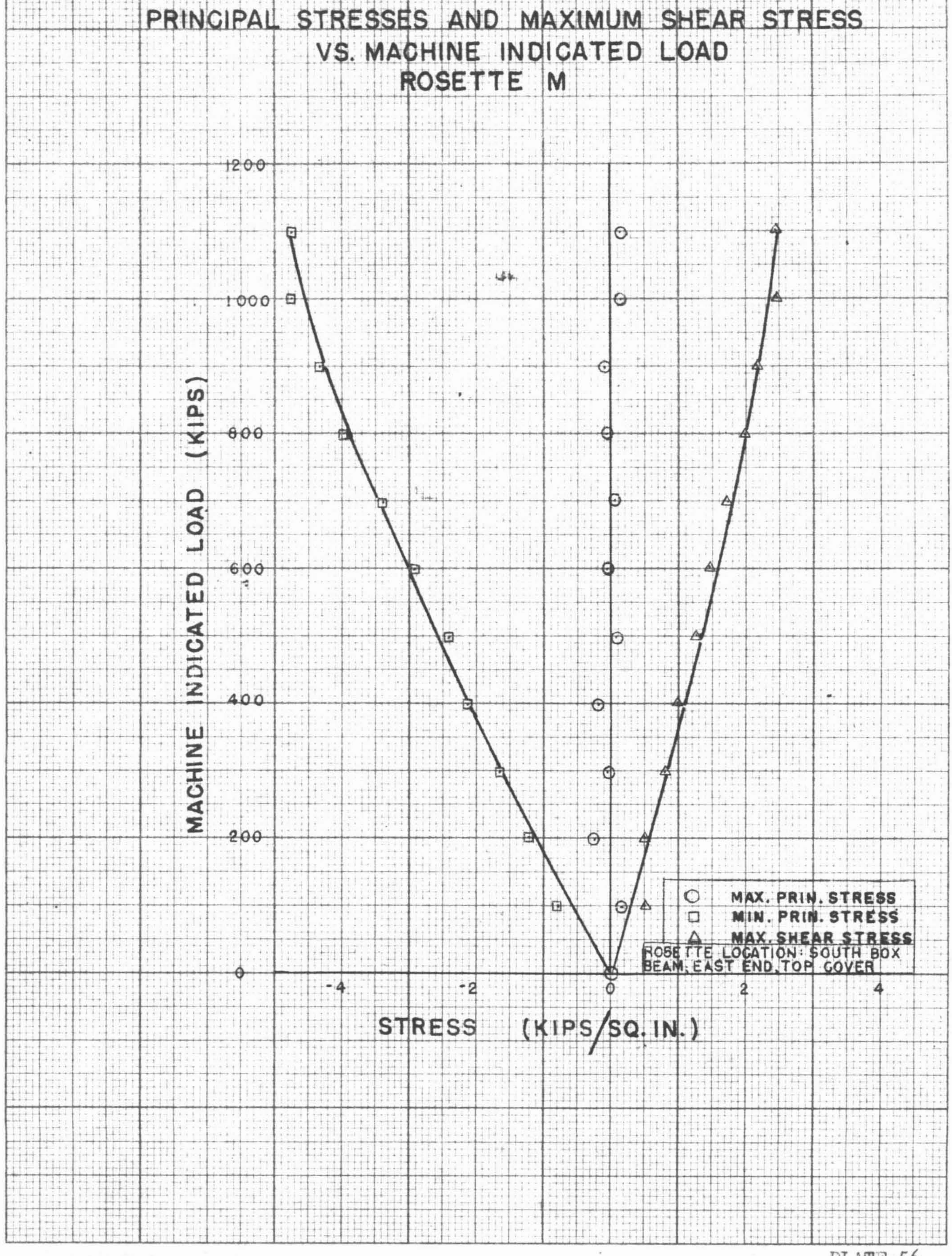
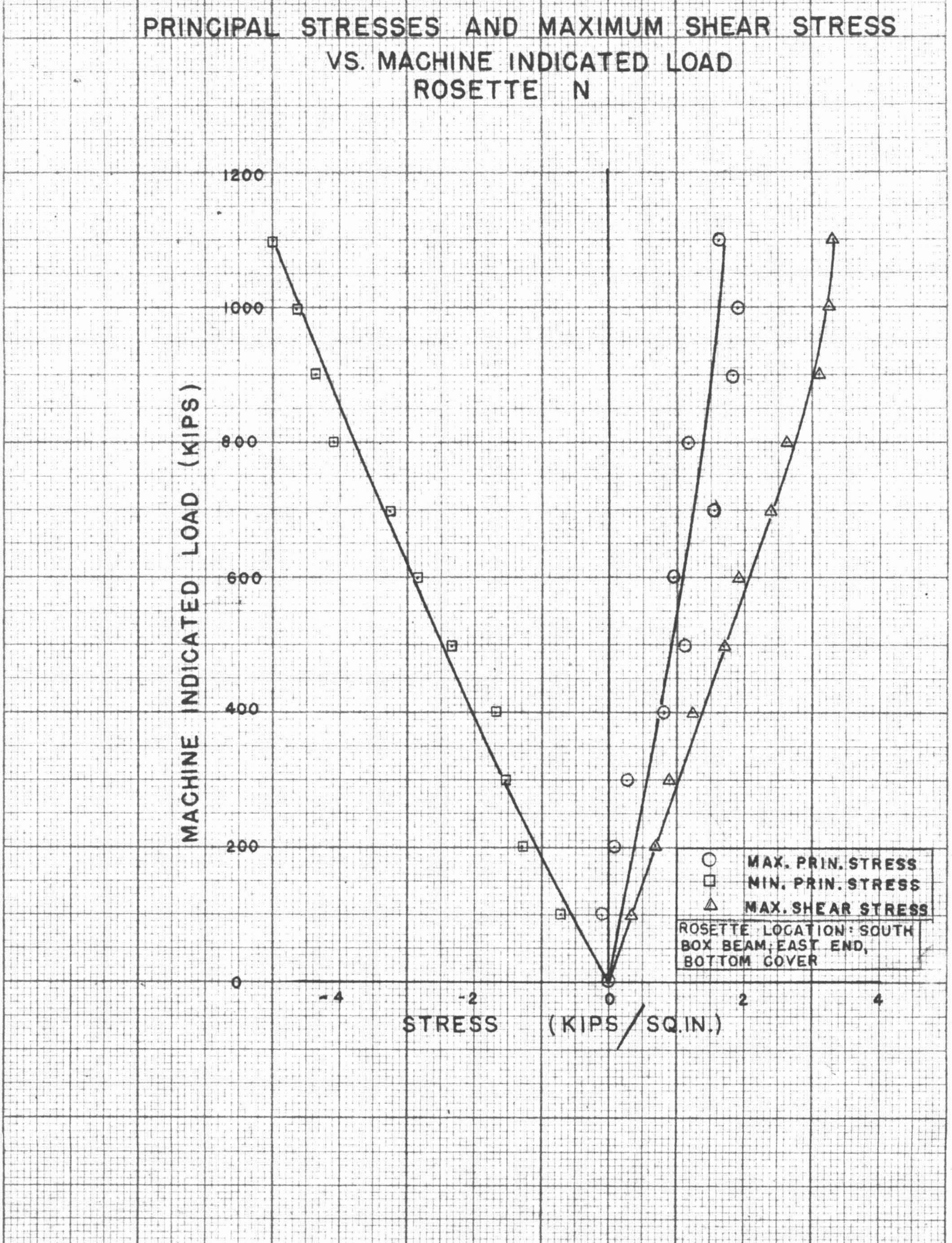
PART II

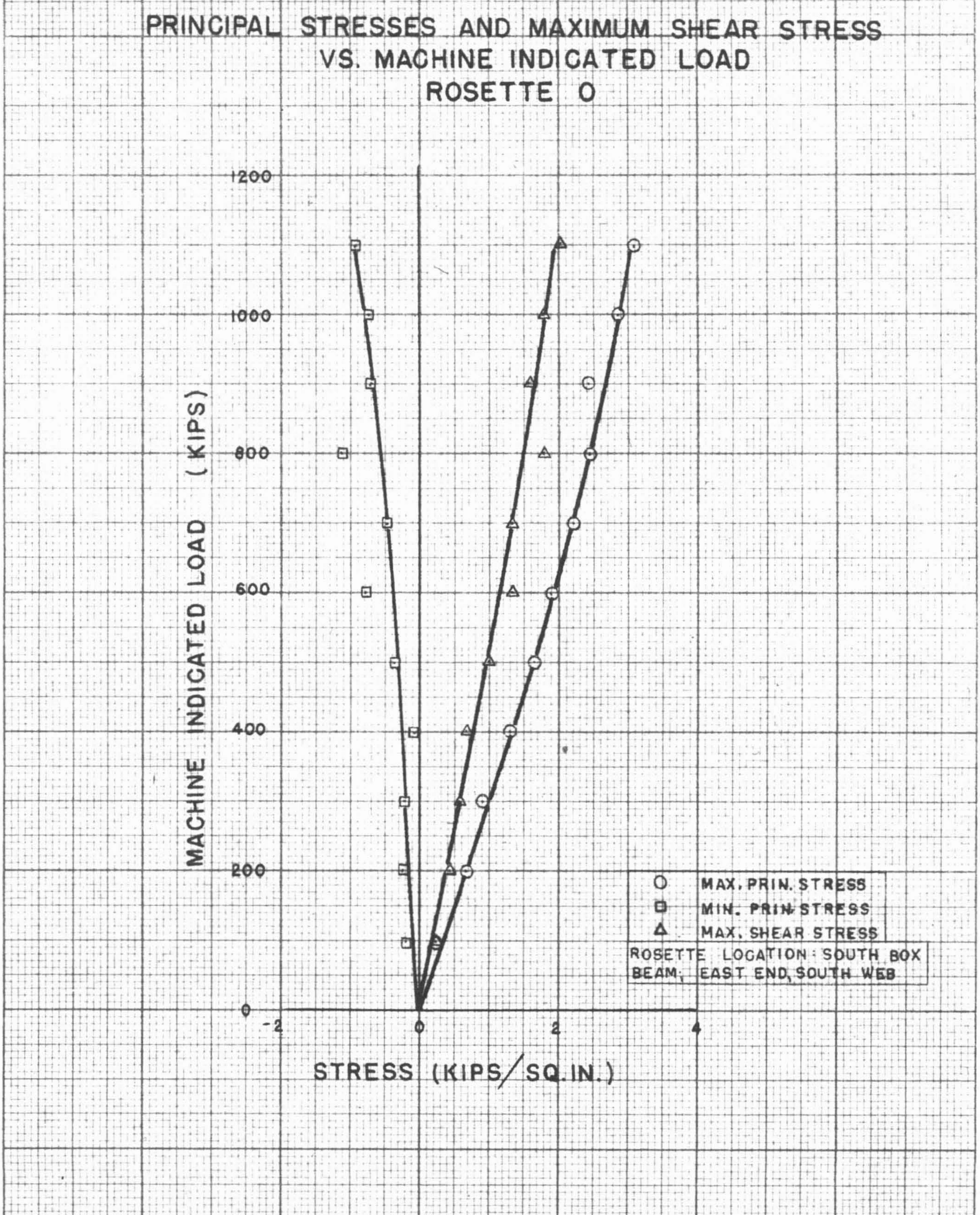
PLATE 53


PRINCIPAL STRESSES AND MAXIMUM SHEAR STRESS
VS. MACHINE INDICATED LOAD
ROSETTE K
MACHINE INDICATED LOAD (KIPS)
1200
1000
800
600
400
200
0
-2
0
2
STRESS (KIPS/SQ. IN.)
MAX. PRIN. STRESS
MIN. PRIN. STRESS
MAX. SHEAR STRESS
ROSETTE LOCATION: SOUTH BOX BEAM, CENTER SOUTH WEB


PRINCIPAL STRESSES AND MAXIMUM SHEAR STRESS
VS. MACHINE INDICATED LOAD
ROSETTE L
MACHINE INDICATED LOAD (KIPS)
1200
1000
800
600
400
200
0
-2
0
2
STRESS (KIPS/SQ.IN.)
MAX. PRIN. STRESS
MIN. PRIN. STRESS
MAX. SHEAR STRESS
ROSETTE LOCATION : SOUTH
BOX BEAM, CENTER NORTH WEB


PRINCIPAL STRESSES AND MAXIMUM SHEAR STRESS
VS. MACHINE INDICATED LOAD
ROSETTE M
MACHINE INDICATED LOAD (KIPS)
1200
1000
800
600
400
200
0
-4
-2
0
2
4
STRESS (KIPS/SQ. IN.)
MAX. PRIN. STRESS
MIN. PRIN. STRESS
MAX. SHEAR STRESS
ROSETTE LOCATION: SOUTH BOX BEAM, EAST END, TOP COVER


PRINCIPAL STRESSES AND MAXIMUM SHEAR STRESS
VS. MACHINE INDICATED LOAD
ROSETTE N
MACHINE INDICATED LOAD (KIPS)
1200
1000
800
600
400
200
0
-4
-2
0
2
4
STRESS (KIPS/SQ.IN.)
MAX. PRIN. STRESS
MIN. PRIN. STRESS
MAX. SHEAR STRESS
ROSETTE LOCATION: SOUTH BOX BEAM, EAST END, BOTTOM COVER


PRINCIPAL STRESSES AND MAXIMUM SHEAR STRESS
VS. MACHINE INDICATED LOAD
ROSETTE O
MACHINE INDICATED LOAD (KIPS)
1200
1000
800
600
400
200
0
-2
0
2
4
STRESS (KIPS/SQ.IN.)
MAX. PRIN. STRESS
MIN. PRIN STRESS
MAX. SHEAR STRESS
ROSETTE LOCATION: SOUTH BOX BEAM, EAST END, SOUTH WEB

INSTALLING TEST GIRDER IN 5,000,000 LB. MACHINE

PHOTO: NA46(I)-270305(L)-6-50

PHOTO NO. 59

LIFTING TEST GIRDER IN 5,000,000 LB. MACHINE FOR PLACEMENT OF END FIXTURES

PHOTO: NA46(I)-270306(L)-6 50

PHOTO NO. 60

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NAVAL AIR [illegible] STATION
NAVAL AIR [illegible] CENTER
U. S. NAV [illegible] STATION
[illegible] PA.